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CORRELATION STRUCTURE AMONG COUNTRIES OR INDUSTRIES AND ITS IMPLICATIONS FOR INTERNATIONAL DIVERSIFICATION AND PORTFOLIO MANAGEMENT

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ABSTRACT

CORRELATION STRUCTURE AMONG COUNTRIES OR INDUSTRIES AND ITS IMPLICATIONS FOR INTERNATIONAL DIVERSIFICATION AND PORTFOLIO MANAGEMENT

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Diversification is an important factor in risk reduction for investors and portfolio managers. Return correlations among international markets are important for determining the diversification strategy. Analysis of correlation structure among international assets helps in analyzing the effectiveness of international portfolio diversification. The main purpose of this study is to investigate the effectiveness of international diversification options through local industry or local country indexes and to examine how well these correlations predict future index returns. Firstly, monthly average pair-wise return correlations, based on two distinct samples of local industry and local country indexes, are calculated using daily index-return data within a month over the research period. Then, monthly average correlations against global market return, implied correlations from asset pricing models with a single factor, with Fama-French three factors, with six factors and idiosyncratic correlations are calculated over the research period. The time-series behavior of average correlations is examined using stationarity tests. Tests for the stationarity of the average correlation series have implications for international investors seeking efficient diversification. The average correlations are examined to compare local industries and local countries by conducting mean difference tests. Developed and emerging countries are also compared to examine their diversification potential. Secondly, monthly sample correlations, implied correlations from the global Fama-French three-factor model and idiosyncratic correlations from the global Fama-French three-factor model are calculated based on local industry and local country indexes for an extended data set over the new research period. Cross-sectional Fama-Macbeth regression analyses are

employed to examine the relationship between returns and correlations. Further details are then given by conducting sub-sample and sub-period analyses. The results show that correlations do not rise permanently over time. Therefore, international diversification can still be applied to reduce portfolio risk and stabilize asset returns. The results also show that diversifying across local industries rather than local countries is more efficient. Average slope estimates of correlation coefficients from Fama-MacBeth regressions for local industry indexes are significantly different from zero whereas those for local country indexes do not differ from zero. Thus, correlation coefficients for local industry indexes have substantial predictive power on future returns.

Key Words: international portfolio diversification, return correlation, portfolio management, local industry index, local country index

ÖZ

ÜLKELER VEYA ENDÜSTRİLER ARASINDAKİ KORELASYON YAPISI VE ULUSLARARASI ÇEŞİTLENDİRME VE PORTFÖY YÖNETİMİ İÇİN ÇIKARIMLARI

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Çeşitlendirme, yatırımcılar ve portföy yöneticileri için risk azaltma açısından önemli bir faktördür. Uluslararası piyasalar arasındaki getiri korelasyonu, çeşitlendirme stratejisinin belirlenmesi açısından önemlidir. Uluslararası varlıklar arasındaki korelasyon yapısının analizi, uluslararası portföy çeşitlendirmesinin etkinliğini analiz etmeye yardımcı olmaktadır. Bu çalışmanın temel amacı, yerel endüstri veya yerel ülke endeksleri aracılığıyla uluslararası çeşitlendirme seçeneklerinin etkinliğini araştırmak ve bu korelasyonların gelecekteki endeks getirilerini ne derece iyi tahmin ettiğini incelemektir. Öncelikle, iki farklı örneklem olan yerel endüstri ve yerel ülke endekslerine dayanan aylık ortalama ikili getiri korelasyonları, araştırma dönemi boyunca bir ay içindeki günlük endeks-getiri verileri kullanılarak hesaplanmıştır. Daha sonra küresel piyasa getirisine karşı aylık ortalama korelasyonlar, tek faktörlü, Fama-French üç faktörlü ve altı faktörlü varlık fiyatlama modellerinden türeyen korelasyonlar ve kendine özgü korelasyonlar araştırma dönemi üzerinden hesaplanmıştır. Ortalama korelasyonların zaman-serisi davranışı durağanlık testleri kullanılarak incelenmiştir. Ortalama korelasyon serisinin durağanlığına yönelik testlerin, etkin çeşitlendirme arayan uluslararası yatırımcılar için çıkarımları vardır. Ortalama korelasyonlar için ortalama fark testleri yapılarak yerel endüstriler ve yerel ülkeler karşılaştırılmıştır. Gelişmiş ve gelişmekte olan ülkeler de uluslararası çeşitlilik potansiyelleri açısından karşılaştırılmıştır. İkinci olarak, aylık örneklem korelasyonları, küresel Fama-French üç faktör modelinden türeyen korelasyonlar ve küresel Fama-French üç faktör modelinden türeyen kendine özgü korelasyonlar, yeni araştırma dönemi boyunca genişletilmiş bir veri seti için yerel endüstri ve yerel ülke

endekslerine dayalı olarak hesaplanmıştır. Getiriler ve korelasyonlar arasındaki ilişkiyi incelemek için kesitsel Fama-Macbeth regresyon analizleri kullanılmıştır. Daha sonra alt-örneklem ve alt-dönem analizleri yapılarak daha fazla ayrıntı verilmiştir. Sonuçlar, korelasyonların zamanla kalıcı olarak yükselmediğini göstermektedir. Bu nedenle, portföy riskini azaltmak ve varlık getirilerini stabilize etmek için uluslararası çeşitlendirme hala uygulanabilmektedir. Sonuçlar ayrıca yerel ülkeler yerine yerel endüstriler üzerinden çeşitlendirmenin daha etkin olduğunu göstermektedir. Yerel endüstri endeksleri için ortalama korelasyon katsayı ölçüleri anlamlıyken, korelasyon katsayılarının ortalama ölçüleri yerel ülke endeksleri için çoğunlukla anlamsızdır. Bu nedenle, yerel endüstri endeksleri için ortalama korelasyon katsayıları ölçümleri, gelecek getiriler üzerinde önemli bir tahmin gücüne sahiptir.

Anahtar Kelimeler: uluslararası portföy çeşitlendirmesi, getiri korelasyonu, portföy yönetimi, yerel endüstri endeksi, yerel ülke endeksi

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Seher Gören Yargı

İzmir, 2021

TEXT OF OATH

I declare and honestly confirm that my study, titled "CORRELATION STRUCTURE AMONG COUNTRIES OR INDUSTRIES AND ITS IMPLICATIONS FOR INTERNATIONAL DIVERSIFICATION AND PORTFOLIO MANAGEMENT" and presented as a PhD Thesis, has been written without applying to any assistance inconsistent with scientific ethics and traditions. I declare, to the best of my knowledge and belief, that all content and ideas drawn directly or indirectly from external sources are indicated in the text and listed in the list of references.

Seher Gören Yargı

Signature

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April 7, 2021

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SYMBOLS AND ABBREVIATIONS

ABBREVIATIONS:

ADF	Augmented Dickey-Fuller
BAB	Betting against Beta
BAC	Betting against Correlation
BAV	Betting against Volatility
CAPM	Capital Asset Pricing Model
DCC	Dynamic Conditional Correlation
EBIT	Earnings Before Interest and Taxes
EBITDA	Earnings Before Interest Taxes Depreciation and Amortization
EGARCH	Asymmetric Dynamic Conditional Correlation Multivariate
EU	European Union
FF3F	Fama-French Three-Factor
FTSE	Financial Times Stock Exchange
HML	High Minus Low
ICAPM	International Capital Asset Pricing Model
ICB	Industry Classification Benchmark
LHML	Local High Minus Low
LM	Local Market Risk
LSMB	Local Small Minus Big
MPT	Modern Portfolio Theory
NBER	National Bureau of Economic Research
NCC	Number of Correlation Combinations
SMB	Small Minus Big

CHAPTER 1
INTRODUCTION

International diversification can help manage risk and facilitate the long-term growth of portfolio value by investing in markets from other countries or industries. In the literature, there is bulk empirical evidence showing that the risk of a diversified portfolio is less than the combined risks of the individual assets forming the portfolio (Grubel, 1968; Levy and Sarnat, 1970; Solnik 1974; Roll, 1992; Odier and Solnik, 1993; De Roon et al., 2001; Eun et al., 2008; Eun et al., 2010; Kroencke et al., 2014; Miralles-Quiros and Miralles-Quiros, 2017). However, according to modern portfolio theory (MPT), correlations between assets or portfolios are an important factor in determining the degree of diversification achieved (Markowitz, 1952; Markowitz and Todd, 2000; Markowitz, 2015). MPT, which was developed by Markowitz (1952), emphasizes the long-term benefits of a well-diversified portfolio. Markowitz (1952) firstly demonstrated that a diversified portfolio can ensure better performance and less risk relative to individual assets. The key concept is the correlation structure among assets or portfolios. Correlation is an important measure indicating how portfolios, assets, investments, etc. move in relation. It can range from -1 (perfect negative correlation) via 0 (no correlation) to +1 (perfect positive correlation). If international markets are perfectly integrated, a single world market completely dominates individual national markets and cross-national return correlations equal to 1. In this case, international diversification does not matter because it cannot reduce risk. Conversely, if national markets are completely or partly segmented, cross-national correlations are less than one and international diversification over countries can reduce risk (Hunter and Coggin, 1990: 33). In other words, if assets or portfolios do not move up and down exactly together, then diversified portfolios entail less risk than the average risk of their parts. Low correlations among international assets or portfolios mean that diversification reduces risk more.

If international markets are perfectly integrated, the cross-national return correlations will be equal to one. Therefore, international investors cannot benefit from diversification in terms of risk reduction. If national markets are segmented, cross-national return correlations will be less than one and international diversification will allow to reduce the risk for investors and portfolio managers. Correlations may differ depending on whether markets are segmented or integrated. There will be an increase in correlated market movements if correlations between countries rise over time due to the globalization. More specifically, local economies are becoming much dependent on each other because of the increasing volume of international trade and the removal of barriers to cross-border trade and capital flows (Umutlu et al., 2010a, Umutlu et al., 2010b). However, some countries that are especially isolated from other countries do not interact economically, so they are not completely integrated into the global market. If the correlations between countries are decreasing or not increasing despite globalization, international diversification can decrease risk. However, if correlations between countries are increasing over time, then international diversification will not decrease risk, so other methods should be considered.

The main purpose of this thesis is to investigate the correlation structure among local industries or local countries and identify its implications for international diversification and international portfolio management. Specifically, it examines how correlations among local industries or local countries affect an investor's decision-making concerning international diversification. Chapter Three explores the trend of average correlations over time. In particular, the chapter evaluates whether the benefits of international diversification can be achieved through an allocation based on local industry and local country indexes, and hence whether investors should diversify internationally to reduce their portfolio risk. If international diversification still provides benefits because correlations do not rise significantly over time, then whether diversifying across which asset class - local industries or local countries - has more diversification benefits is observed. Chapter Four examines the relationship between index returns and return correlations to evaluate the ability of correlation estimates to predict future index returns. Before investors make an investment decision, they should review their investment strategy to gain diversification benefits. The results of this study have substantial implications for international diversification.

In Chapter Three, correlation analyses are conducted to observe the trend of average correlations over time. Four types of correlation are calculated for both local industry and local country indexes using daily return data within a month: pair-wise correlations,

correlations against global market return, implied correlations from asset pricing models and idiosyncratic correlations implied by the difference between sample covariance and systematic covariance. Three asset pricing models are used to analyze implied correlations: a single-factor model, the Fama-French three-factor (FF3F) model and the regional asset-pricing model with six factors. After each analysis, the time-series averages of the monthly correlations within the research period are calculated. After the correlation analyses, unit root tests are conducted to analyze whether the time-series behavior of the average correlations is stationary or not. If markets are fully integrated, then average correlations increase over time and do not remain stationary. In this case, there is no gain from international diversification in terms of risk reduction. Conversely, if markets are not fully integrated, then average correlations do not increase over time. This suggests that there is still room for international diversification. After conducting unit root tests, mean difference tests are used to compare the mean level of correlations of local industries and local countries, and those of developed and emerging markets. This enables the differences to be investigated between mean correlations of return on local industries versus local countries from the same country groups. All the analyses performed for 37 local country indexes are also implemented for developed and emerging countries by examining the differences between the mean correlations of the same indexes from developed and emerging markets. The results in Chapter Three show that international diversification is still beneficial despite globalization. More efficient diversification can be obtained through diversifying across local industries rather than local countries. Moreover, international diversification provides more benefits through indexes of emerging markets rather than developed markets.

Chapter Four considers the data sample after it is extended to 63 local country indexes. Firstly, three types of correlation estimates are calculated for both local industry and local country indexes using daily return data within a month: sample correlations, and both implied and idiosyncratic correlations from the global FF3F model. Cross-sectional Fama-Macbeth regression analyses are then conducted to examine the predictive power of correlations for future index returns. That is, Chapter Four evaluates how well correlation measures explain returns and the power of average correlations to predict future returns on local industry and local country indexes. The chapter analyzes whether these observations can help international investors manage their portfolios. Finally, a set of robustness checks are employed for local countries and additional information is provided for local industries using sub-sample and sub-period analyses. The power of the correlation estimates to explain index returns is evaluated for these samples. The results presented in Chapter Four show that international investors and portfolio managers can gain more benefits by diversifying through local industries than local countries. Average correlation is a significant predictor of future index returns. The results of the sub-samples and sub-periods support the results of the full sample.

The findings of this study indicate that investors and portfolio managers can gain substantial benefits from international diversification unless international assets or portfolios move in perfect harmony.

This thesis contributes to the literature by analyzing the relationship between correlations and returns from a perspective of asset pricing models. Implied correlations are estimated by derivations within a multi-factor model, namely the FF3F model. The study also provides evidence that the derivation of implied correlations from sample correlations is only significant in a multi-factor model. Therefore, it also estimates idiosyncratic correlations from the FF3F model based on sample correlations and implied correlations from the FF3F model. The analyses are also performed at the index level using both industry and country indexes as the basic assets to analyze the relationship between correlations and returns. The study also provides direct evidence that a portfolio that earns abnormal returns can be constructed based on correlations using the results of the analyses.

The remainder of this chapter describes Markowitz's MPT while the rest of this dissertation is organized as follows. Chapter Two reviews the relevant literature. Chapter Three presents the time-series behavior of correlations among industries or countries and considers its implications. Chapter Four presents the correlations and their index return predictive power, and their implications. Chapter Five reaches some conclusions based on the findings.

1.1. Markowitz's MPT

MPT explains how investors can create portfolios of multiple assets to maximize expected return based on a given level of market risk or minimize risk based on a given level of expected return. It thus involves finding the balance between maximizing return and minimizing risk. Harry Markowitz laid the foundations of this theory in his 1952 paper “Portfolio Selection” (Markowitz, 1952: 77).

More advanced investment decisions require an understanding of MPT to construct an efficient and optimal portfolio, which can include stocks, bonds, funds and other securities. The availability of these asset classes raises the issue of asset allocation in portfolio management (Grinblatt and Titman, 1992: 1977). One of the factors determining portfolio performance is the asset allocation decision, which is generally based on past performance or arbitrary selection process (Brinson et al., 1991: 40).

While historical performance may affect expected returns, it is an important issue whether past performance can continue in the future. Past volatility also influences risk. However, as with returns, investors should critically consider the assumptions underlying risk estimates (Bromiley, 1991: 42). MPT is used to reduce risk (portfolio variance) while increasing expected return. Portfolio variance corresponds to the total risk of a portfolio. Thus, the preferred portfolio is decided by considering the expectations of investors and portfolio managers.

1.1.1. Assumptions of MPT

MPT, which is also known as mean-variance theory, aims to maximize a portfolio’s expected return for a given level of risk by choosing from the opportunity set. Many researchers assert that holding one stock is riskier than holding two stocks in a portfolio because diversification reduces risk. MPT guides investors and portfolio managers towards finding optimal diversification. Thus, it clarifies how portfolio risk can be reduced by diversification (Elton and Gruber, 1997: 1745).

Risk is associated with investment due to MPT which is based on the following assumptions (Amling, 1989: 590):

- Investors behave rationally and are risk-averse. They prefer greater returns to lesser returns with equally small risks. That is, they prefer the investment with the smaller risk between two investments with equal expected returns.

- Investors avoid risk. Here, risk aversion means that they prefer the minimum risk for a given expected return and maximum expected return for a given level of risk.

- Investment decisions are based on two measures: expected return and variance of return.

- Investors' risk estimates are proportional to the return variance for securities and portfolios. Thus, they estimate the risk based on the variability of expected return.
- Investors consider each investment opportunity by a probability distribution of returns over a holding period.
- Investors have access to all sources of information for their investment decisions.
- Investors have unlimited access to borrowing or lending money options at a risk-free rate.
- Investors do not need to pay taxes and transaction costs.
- Markets are efficient while prices reflect all incorporated and available information. It is impossible to beat the market, so investors cannot purchase undervalued stocks and sell overvalued stocks. Investors also cannot outperform the market through the selection of stocks and market timing. An investor can only get higher returns by purchasing riskier investments.
- Investors have no effect on the price in the market.
- Risk can be reduced by adding new securities to the portfolio.
- Investors can increase their rate of return by focusing on an efficient portfolio model.
- Awareness of correlations among various securities in the portfolio influences risk reduction, as quantitatively proven in Markowitz's mean-variance model by (Harrington, 1987: 9).

1.1.2. MPT versus Traditional Portfolio Theory

Traditional portfolio theory is useful for investors who make investments by evaluating the return and risk conditions of each security. Such investors attain the maximum possible return for a minimum risk level. To estimate the return on a security, they focus on the number of dividends of a company, the price-earnings ratios, market value of shares, etc. Risk can also be measured for each security by estimating the standard deviation. The security with the lowest standard deviation can be preferred as greater variability as measured by a higher standard deviation is associated with higher risk. Traditional portfolio theory takes a nonquantitative approach. That is, to reduce risk, a portfolio should include a variety of assets (such as stocks, bonds, funds and other securities) from different sectors (Farell, 2004: 39).

Both modern and traditional portfolio theory are related to risk and return while diversification is important for both. However, according to MPT, diversification is not the only factor to achieve maximum returns. The securities are selected, the portfolio is analyzed in terms of risk and return and the risk is quantified. Asset selection to reduce portfolio risk is managed through statistical techniques, specifically by calculating expected returns, standard deviations of securities and correlation coefficients among assets (Temizkaya, 2006: 23).

Thus, the main difference between traditional and MPT is that the latter uses quantitative methods to reduce risk (Üstünel, 2000: 9) by describing investments statistically and mathematically. Portfolio variance is an important measure of investment risk while correlation coefficients are included in the portfolio variance equation. Any change in the correlation coefficient changes the portfolio variance. Therefore, this study analyzes correlation coefficients as they enable the degree of co-movement to be investigated.

Equation (1.1) represents the variance of a portfolio with many assets. It shows that variance (risk) calculation of a portfolio is not simply a weighted average of the variances of the securities in the portfolio (Li et al., 2010: 3):

$$\sigma_p^2 = \sum_{i=1}^{Q} \sum_{j=1}^{Q} \left(w_i w_j \rho_{ij} \sigma_i \sigma_j \right) \tag{1.1}$$

where "σ_p^2" is the variance of a portfolio, "Q" is the total number of stocks in the portfolio, "w_i" and "w_j" are the percentages invested in each stock, the remaining part is the covariance between stock "i" with stock "j", "σ_i" is the standard deviation of stock "i", "σ_j" is the standard deviation of stock "j" and "ρ_{ij}" is the correlation coefficient between stock "i" and stock "j". Covariance is a statistical measure indicating the direction comovement between two assets. MPT uses covariance as an important factor in portfolio construction.

Equation (1.2), which is derived from Equation (1.1) and using the same variables, represents the portfolio variance with two stocks. It clearly shows that there is a relationship between the correlation coefficient and risk (Markowitz and Todd, 2000: 21).

$$\sigma_p^2 = w_1^2\sigma_1^2 + 2w_1w_2\rho_{12}\sigma_1\sigma_2 + w_2^2\sigma_2^2 \tag{1.2}$$

The variance or standard deviation of return is a statistical measure of the risk in an investment. Combining more than one security in a portfolio is known as diversification, which has the main purpose of reducing risk. Risk reduction can be achieved even when two securities are uncorrelated (Copeland et al., 2005: 160).

The effect of covariance or the correlation coefficient on portfolio risk should be investigated in detail to understand the functioning of diversification. Correlation coefficients always range from -1 to +1. If two stocks are perfectly positively correlated in a portfolio, their correlation coefficient will be +1 (Copeland et al., 2005: 160). Including this in the portfolio variance equation yields Equation (1.3).

$$\sigma_p^2 = w_1^2\sigma_1^2 + 2(+1)w_1w_2\sigma_1\sigma_2 + w_2^2\sigma_2^2 \tag{1.3}$$

Hence the variance of such a portfolio is as below:

$$\sigma_p^2 = (w_1\sigma_1 + w_2\sigma_2)^2 \tag{1.4}$$

When security returns are perfectly positively correlated, diversification leads just risk averaging (no risk reduction) because a portfolio’s risk level cannot be reduced below the risk level of individual securities (Copeland et al., 2005: 161).

If two stocks are perfectly negatively correlated in a portfolio, the correlation coefficient will be -1. Including this in the portfolio variance equation yields Equation (1.5).

$$\sigma_p^2 = w_1^2\sigma_1^2 + 2(-1)w_1w_2\sigma_1\sigma_2 + w_2^2\sigma_2^2 \tag{1.5}$$

Hence the variance of such a portfolio is as below:

$$\sigma_p^2 = (w_1\sigma_1 - w_2\sigma_2)^2 \tag{1.6}$$

When the security returns are perfectly negatively correlated, the portfolio may have no risk. Thus, diversification can reduce or eliminate portfolio risk. However, it is very hard to find perfectly negatively correlated securities (Copeland et al., 2005: 161).

Correlation is a standard version of covariance, which simply indicates the direction of the co-movement of stock returns rather than the intensity of co-movement. That is, it does not show the strength of the relationship between stock returns whereas correlation coefficients not only specify the direction but also measure the degree that stocks move together. If stock returns are positively correlated, they tend to move together (whether up or down). The relationship between stock returns strengthens as the correlation coefficient moves closer to +1. Conversely, if stock returns are negatively correlated, they tend to move in opposite directions. The relationship between stock returns strengthens as the correlation coefficient moves closer to -1. Finally, if the correlation coefficient between stock returns is 0, there is no relationship between stock returns, so they move independently. That is, they are uncorrelated (Zhang, 1997: 378).

Overall risk can be reduced by diversifying assets with negative correlation coefficients in the portfolio. When security returns are uncorrelated, diversification may reduce portfolio risk while risk can also be reduced by selecting assets that are not perfectly positively correlated. When two assets are perfectly positively correlated, there is no diversification benefit. In short, diversification can reduce risk in all cases except when security returns are perfectly positively correlated. As the correlation coefficient declines from +1 to -1, the standard deviation of a portfolio also falls. However, risk reduction is greater if the security returns are negatively correlated. All the notions described so far can be represented graphically.

Figure 1.1 shows several two-security portfolios with different correlations. It shows the risk-return trade-offs available to the investor for two assets. The horizontal axis represents risk while the vertical axis represents expected return. The straight line between the standard deviation of stock A and stock B represents two perfectly positively correlated securities. The line shows the risk and return for all combinations of two perfectly positively correlated securities. Each point on the line represents a different weight in securities (Copeland et al., 2005: 162).

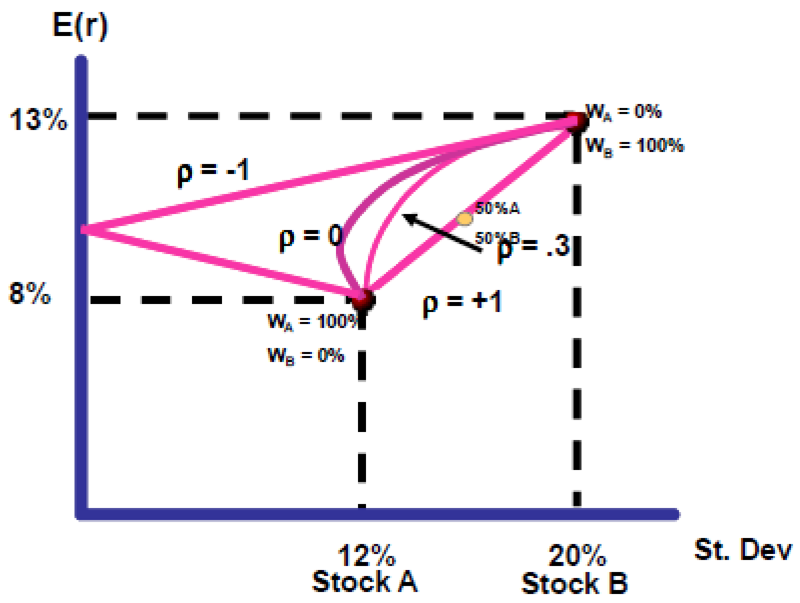

Figure 1.1. Two-Security Portfolios with Different Correlations

Source: Portfolio Optimization (2018). Retrieved January 30, 2018, from https://people.ucsc.edu/ ~ealdrich/Teaching/Econ133/LectureNotes/portfolioOpt.html.

The broken line in Figure 1.1 represents two perfectly negatively correlated securities. It is possible to construct a portfolio for these securities with zero variance. The slope of the straight line between the standard deviation of 0% and 20% is positive whereas the slope of the straight line between the standard deviation of 0% and 12% is negative (Copeland et al., 2005: 163).

The parabolic lines in Figure 1.1, which represent two securities with a correlation lower than +1 and higher than -1, show that the amount of risk reduction depends on the correlation. If it is lower than +1, then it reduces risk. Therefore, there are always diversification benefits from combining such securities.

1.1.3. Efficient Frontier

In constituting the risk-return relationship, Markowitz introduced the efficient frontier concept. The covariance or correlation coefficient is used to form an optimal portfolio based on Markowitz's selection technique. According to his MPT, the most efficient portfolio can be constructed by combining several securities. This optimal combination can be achieved in many ways (Best and Hlouskova, 2000: 197).

The efficient frontier specifies the set of assets constituting the optimal portfolio. An efficient frontier of optimal portfolios that have a possible expected return for a given risk level can be constructed using MPT. Different portfolio combinations must be compared to select the optimal portfolio. A portfolio is more efficient than other portfolios when it generates higher expected returns and lower standard deviation (risk) or higher expected returns and the same standard deviation. When portfolios have the same expected returns, the one having the lower standard deviation is more efficient than the others. If a portfolio is not efficient, investors may construct some combinations of increased expected return and decreased risk. This is possible for a portfolio by switching to it on the efficient frontier (Frost and Savarino, 1986: 294).

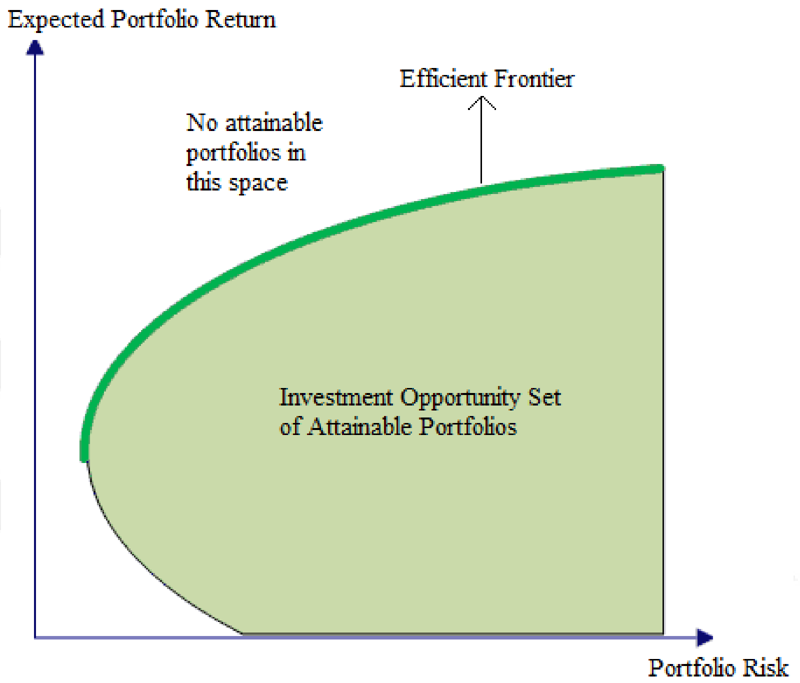

Figure 1.2. Efficient Frontier and Investment Opportunity Set

Source: Modern Portfolio Theory: Efficient and Optimal Portfolios (2018). Retrieved February 1, 2018, from http://thismatter.com/money/investments/modern-portfolio-theory.htm.

MPT identifies an efficient frontier for a set of assets in a portfolio. The efficient frontier computes the maximum return for a portfolio with a specific risk level for a successful combination of assets. The aim is to generate a mix of assets with the lowest possible standard deviation. As Figure 1.2 shows, the efficient frontier is curved and explains how higher risky assets must be mixed with lower risky assets to maximize returns (Murillo-Zamorano, 2004: 35).

Because portfolios are formed from different proportions of a certain number of assets, there is a wide range of possible risk-return ratios, known collectively as the investment opportunity set (Murillo-Zamorano, 2004). The area of the investment opportunity set can be plotted by including all possible portfolios (Figure 1.2). The vertical axis represents the expected return while the horizontal axis represents the risk. As Figure 1.2 shows, the possible portfolio set includes many available portfolios offering the highest return for each risk level. The efficient frontier contains the set of efficient portfolios generating the highest return for each risk level. The optimal portfolio, which is determined based on the utility function of an investor, may be found from the efficient frontier (Li and Ng, 2000: 387).

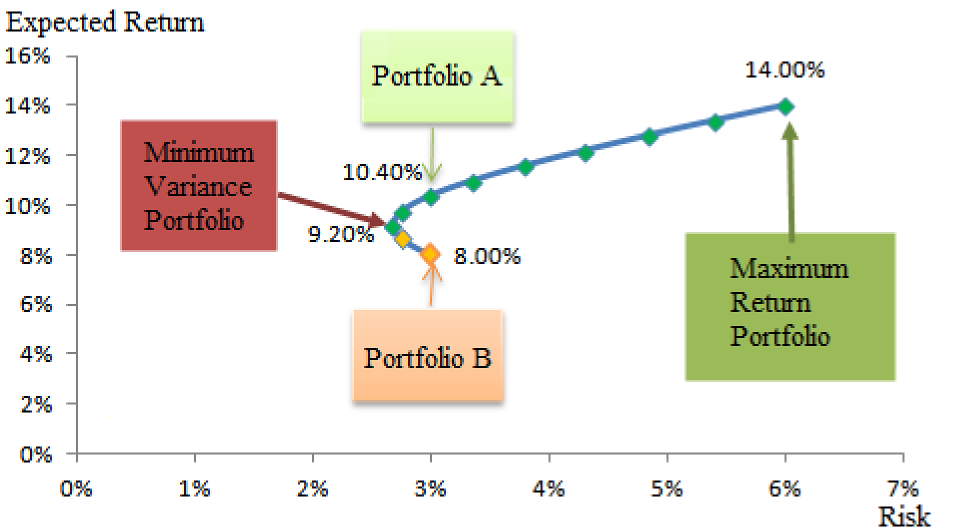

Figure 1.3. Various Portfolios on the Efficient Frontier

Source: Modern Portfolio Theory: Efficient and Optimal Portfolios (2018). Retrieved February 1, 2018, from http://thismatter.com/money/investments/modern-portfolio-theory.htm.

Figure 1.3 shows various portfolios on the efficient frontier. The frontier includes the portfolio with the lowest risk (but also lowest return), known as the minimum variance portfolio. Conversely, the frontier also includes the maximum return portfolio (but with the highest risk). Investors avoid portfolios in the area under the efficient frontier because they offer lower returns for the same risk level (Frost and Savarino, 1986).

As Figure 1.3 shows, the efficient frontier extends from the minimum variance portfolio to the maximum return portfolio. Although portfolios A and B have the same risk level (3%), portfolio A generates a greater return. Thus, a risk-averse investor who is only willing to accept 3% risk would choose portfolio A over B. Moreover, since the minimum variance portfolio generates greater expected return and lower risk than portfolio B, the latter is not on the efficient frontier (Modern Portfolio Theory:

Efficient and Optimal Portfolios (2018). Retrieved from http://thismatter.com/ money/investments/ modern-portfolio-theory.htm).

In sum, investors, whose decisions are assumed to be based on specific risk-return preferences, choose a portfolio from the set of efficient portfolios on the efficient frontier. The optimal portfolio of securities depends on each investor because of differences in their preferences (Frost and Savarino, 1986).

CHAPTER 2
LITERATURE REVIEW

2.1. Benefits of International Diversification

Physical and financial globalization has increased over the last decades. The substantial literature about this issue has demonstrated that equity market correlations increase when markets integrate financially, which in turn reduces international diversification benefits. Baele and Inghelbrecht (2009) investigated the time-varying benefits of international diversification as local markets integrate with world equity markets. They established a dynamic model based on index returns from 1973 to 2007 with 4 regions, 21 developed countries and 18 global industries. From this, they identified two indicators of diversification potential. The advantage of their factor model was that it dissociated total country and industry risk into their components. Then, the average model-implied cross-country and industry correlations were estimated over time. If market integration and globalization reduce the benefits of international diversification, then average country-specific risk decreases whereas cross-country correlations rise. They found that factor exposures and asset-specific volatilities vary over time. However, in their previous study, there were restrictions of constant and unit factor exposures whereas, according to their current findings, market betas are different from one and there are substantial biases in the country and industry risks. Market betas vary over time for several reasons. As markets integrate, the value of global factor exposures increases approximately from zero to one. As industry characteristics change, industry betas change while industry and country betas also vary over the business cycle. They found that global and regional factors determined how much country-specific risk can be eliminated by diversifying regionally. They also added structural economic variables to an asymmetric GARCH specification and showed that betas exhibit structural changes.

According to Baele and Inghelbrecht (2009), the dynamics of market betas vary between industries and countries while the introduction of the euro mainly affected market exposures. Moreover, they found that country-specific risk decreases as market betas rise. Thus, although globalization and integration have reduced the benefits of geographical diversification, geographical diversification reduces risk more than industry diversification.

Many researchers (e.g. Granito, 1994) have concluded that correlation evolves across time. Focusing on international correlations, Solnik et al. (1996) discussed whether international market integration and capital flows have increased correlations over the past 30 years. If correlations rise, international diversification may not have long-term benefits. They also analyzed the relationship between market volatility and correlation, particularly whether correlations rise when market volatility is high. They focused on the correlations among the U.S. stock and bond markets (from 1958 to 1995 and 1959 to 1995 respectively) and the equivalent markets in countries like Germany, the United Kingdom and Japan. The data period is subject to market characteristics. They also considered the relationship between Germany and France because of their significant economic and political integration over the last 20 years and important status within the European Union (EU). They found that stock and bond markets in these countries correlate more as their economic links increase.

Solnik and Roulet (2000) reported that international diversification is more significant when there are low correlations between national equity markets. Investing in different countries diversifies portfolio risk due to low global correlations. Therefore, investors may find assets and markets to gain positive returns. Low global correlations provide some advantages for investors. A general approach to forecast the structure of market co-movements is time-series estimation for market correlations. This method is suggested for studies where the correlations change over time. Investors can partially determine asset allocations based on the international covariance of market returns. The global correlation affects portfolio diversification. Solnik and Roulet (2000) provided an improved method to determine changes in global correlations, based on cross-sectional dispersion of returns and connecting cross-sectional dispersion to global correlations. They tried to show the benefits of cross-sectional global correlations using MSCI World Index data from 1971 to 1998 for monthly returns in U.S. dollars. If market returns change over time, estimates of market correlations are a significant factor for investors because globalization and information flows have a detrimental effect on markets during crises. Their improved dispersion and global correlation measure satisfied this need.

According to Ferreira and Gama (2005), international diversification still has benefits despite globalization. They showed that industry diversification has become more important in recent years, using daily data from 21 countries and 270 industry portfolios for 1974-2001, similar to the findings of Amavilah et al. (2014).

Using data from January 1994 to December 2016, Chen et al. (2019) performed regression analyses to test how commodity financialization affects diversification benefits. Focusing on correlations between the equity and commodity markets, they showed that diversification can protect against stock market downturns. Commodity markets attract the attention of financial investors to benefit from diversification.

Goetzmann et al. (2001) showed that correlations vary over time and are higher than previously. Besides, correlations among financial markets increase during critical economic periods, such as crises and financial integration. They used the stock markets of the U.S., the U.K., France and Germany to estimate average correlations for 1872-2000. They found that diversification benefits are not constant and also lower than the historical level of capital markets.

2.1.1. Diversification Benefits due to Correlations among Industries or Countries

Efficient global portfolio diversification depends on low international correlation. Investors can reduce their total portfolio risk by diversifying across international markets. However, it is important that market returns should have low correlations. Erb et al. (1994) argue that international equity correlations play an important role in international diversification and portfolio management. Recently, the equity market correlations between the U.S. and other G-7 countries have generally fallen. Business cycles affect cross-equity correlations in G-7 countries. If two countries are strongly integrated, then investors can access both capital markets. However, each country may have different industries, resulting in a low equity correlation. Moreover, economic activity plays an important role in changes in correlations. If different countries suffer economic recessions simultaneously then equity correlations are higher than usual. Conversely, if their business cycles are out of phase, equity correlations are lower. Correlations are not symmetric in up and down markets. Moreover, they are higher in down markets with below-average returns (negative semi-correlation). This correlation behavior in the business cycle and correlation behavior between the returns in different states prompted the correlation forecasting model.

Using weekly data on the national stock market and sector indexes for 11 countries from September 1990 to April 1999, Adjaoute and Danthine (2001) found that correlations increased significantly among Economic and Monetary Union (EMU) equity market returns in terms of portfolio diversification opportunities. Therefore, portfolio diversification opportunities fell significantly as correlations among stocks increased. The study of Lessard (1974) is one of the oldest studies that showed the importance of industry structures from the variation in stock returns for monthly data for 16 countries from January 1959 to October 1973. Ferreira and Ferreira (2006) argued that international portfolio selection and returns depend on country and industry factors. Using daily returns for 11 EMU countries from January 1975 to July 2001, they investigated whether industrial factors are more significant than country factors in EMU equity markets. Like some earlier studies (Heston and Rouwenhorst, 1994), they found that countries have more effect than industries over the research period. However, the effect of industry increased trend over time due to economic integration, so an industry diversification strategy is more effective for the most recent periods.

Like Dwyer and Hafer (1988) and Arshanapalli et al. (1997), Roll (1992) showed that intercorrelation among markets is low despite financial globalization. Using daily stock index returns from 24 international markets over three calendar years, he analyzed the behavior of stock price indexes. He found that some indexes are more diversified than others while the country's industry structures determine estimates of stock price behavior. In other words, because of each country's industry structure, there are low correlations of returns among countries. Especially since 1995, industry structures have become more important than countries for international investment. Several studies have focused on this subject during this period (e.g. Baca et al., 2000; Catão and Brooks, 2000; Isakov and Sonney, 2002). Cavaglia et al. (2000) were one of the first to show this trend and that diversification across industries reduces risk more than diversification across countries, which they proved with a factor model for 21 developed countries from January 1986 to November 1999. Wu and Mazouz (2016) explored the industry effect on future stock market returns using industry-level Fama-MacBeth regressions from January 1970 to December 2011. They found that long term-return reversals are substantially industry-driven while industry performance is especially affected by large firms.

Sharma et al. (2013) examined the relationship between the stock market indexes of Brazil, Russia, India, China, and South Africa from April 2005 to March 2010. These stock markets influenced each other, although not greatly. This implies that investors can still find opportunities for international diversification. They also showed that local factors may affect country stock markets.

2.1.2. Volatility-Return Relationship and Diversification

Investors benefit by reducing unsystematic risk through diversification. While many studies are examining the relationship between idiosyncratic risk and excess returns (Umutlu, 2015; Umutlu, 2019), Ang et al. (2006) identified an "idiosyncratic volatility puzzle" in the U.S. market and later in several other markets by Ang et al. (2009). This puzzle arose from cross-sectional analyses, which show that stocks with high idiosyncratic volatilities in the previous time period earn lower future returns. To explain this, several researchers examined the time-series properties of idiosyncratic shocks to determine the risk-expected return relationship for individual countries using cross-sectional firm-level data. For instance, Huang et al. (2010) found that past idiosyncratic volatility reduces expected return if lagged returns are omitted from the regression. Fu (2009) found that lagged idiosyncratic volatility fails to estimate expected idiosyncratic volatility because of time-varying idiosyncratic volatilities while there the estimated idiosyncratic volatility is positively related to stock return. According to Arrow (1970), an investor should prefer positively to negatively skewed portfolios while Boyer et al. (2009) reported a negative correlation between expected idiosyncratic skewness and expected returns. They concluded that past idiosyncratic volatility is a good predictor of future idiosyncratic skewness.

Bali and Cakici (2010) found that the idiosyncratic volatility puzzle does not apply to global markets and that past country-specific idiosyncratic volatility is positively correlated with future index returns. International investors are thus holding under-diversified international portfolios, so the country-specific risk is priced. Driessen and Laeven (2007) found that diversification has less benefit when the correlations between international equity markets increase. Without the idiosyncratic volatility puzzle, the time-series properties of idiosyncratic shocks in both firm-level and country-level data would be different. Moreover, Boyer et al. (2009) concluded that the firm-level relationships among idiosyncratic skewness, volatility and return cannot hold in global equity markets. Bali and Cakici (2010) reported that international investors try not to avoid positively skewed index securities in under-diversified international portfolios. Umutlu (2015) used daily and monthly return data from January 1973 to May 2011 to examine the relation between idiosyncratic volatility and expected returns. Based on different economic conditions, he created four sub-periods: recession vs. expansion, up vs. down markets, high vs. low economic activity and high vs. low market volatility and eight sub-samples. There was no evidence of a relation between idiosyncratic volatility and expected returns, indicating that global diversification across countries and industries remains beneficial. Using the country-level equity index data, Hueng and Yau (2012) examined the time-series properties of country-specific idiosyncratic volatility and skewness to identify many investment strategies in firm-level stock and international index portfolios. They concluded that lagged idiosyncratic volatility performs better with country-level than firm-level index data while idiosyncratic skewness in the country-level index data does not predict index returns and past returns in the country-level index data do not reduce current returns. Using data from 37 countries from January 1973 to November 2010, Hueng and Yau (2012) investigated the time-series properties of country-specific idiosyncratic volatility and its relationship with expected returns to determine the importance of idiosyncratic skewness in international asset pricing.

The literature about the risk-return relationship, reviewed by Pettengill et al. (1995), indicates that the relationship between market beta and returns is conditional on market returns. In down markets, high beta securities earn lower returns than low beta whereas, in up markets, high beta securities have higher returns than low beta securities. Therefore, data must be divided by market characteristics (up and down) based on the sign of market excess return. Empirical studies analyzing data from various countries in Fama-Macbeth cross-sectional regressions show that there is a significant direct relationship between the beta and return in up markets and an inverse relationship between the beta and return in down markets.

Spiegel and Wang (2005), Brockman et al. (2009) and Fu (2009) have all found that the monthly idiosyncratic volatility in daily data and the conditional idiosyncratic volatility in GARCH models using monthly data provide more accurate proxies of expected future idiosyncratic volatility. Bali et al. (2017) used the dynamic conditional correlation (DCC) model (Engle, 2002) to constitute conditional market betas. Using firm-level data, they predicted cross-sectional variations in expected returns by examining the significance of the conditional betas. Hueng (2014) investigated both dynamic idiosyncratic and dynamic systematic risk by applying the DCC model to indexes of country-level equity and world market integration. More specifically, the author applied the Asymmetric Dynamic Conditional Correlation Multivariate EGARCH (A-DCC-MV-EGARCH) model (Cappiello et al., 2006) to the time-varying conditional world beta using Datastream Global Index data for 37 countries' stock market indexes and the world market portfolio for 1973-2012. Finally, there is an extensive literature examining the option-implied volatility as a measure of expected volatility and returns (Fu et al., 2016).

2.1.3. Market Integration and Segmentation

Financial markets significantly influence the level of globalization. The relationship between international capital markets has strengthened due to recent financial crises. That is, globalization makes national stock markets move more closely together while forcing global pricing of international capital assets. Many studies have tried to determine whether the world market and country-specific idiosyncratic risks are priced, and identify the critical effects of local factors.

Bali and Cakici (2010) showed differences in stock market returns of countries and differences in country-specific risks because global stock markets are not fully integrated. This is an important result for international investment because diversification reduces risk. Hueng (2014) searched for strong evidence of global capital market integration.

Bekaert et al. (2011) introduced a new variable measuring the degree of segmentation: segmentation measure as SEG. Their segmentation measure was constructed for 69 countries using monthly equity industry and firm-level data for 1973-2005, although most analyses were conducted for 1980-2005. Using the earnings-to-price ratio, they calculated the difference between each industry's earnings yield in a country and globally as an absolute value for each country. This segmentation measure was calculated from the industry-weighted average of these differences. Thus, it can be considered as the opposite of integration for a country. They proved that emerging markets are still segmented despite increasing integration. Bekaert et al. (2008) estimated their model by combining local and global factors with time-varying betas using weekly data to fit stock market co-movements under the influence of global market integration. They investigated aggregate idiosyncratic volatility for 23 developed equity markets, finding that volatility is highly correlated across countries. The major determinants of time variation in idiosyncratic volatility were total market volatility, three factors, growth opportunities and the variance premium. Bali and Cakici (2010) examined the degree of market integration and segmentation using portfolio-level analyses and country-level cross-sectional regressions. They calculated the average correlations of stock returns using daily return data from January 1973 to September 2006. They found that correlation coefficients between countries increased, indicating that market integration was increasing over time. However, the trend is not powerful enough and international capital markets are not yet fully integrated, as Chaieb and Errunza (2007) and Umutlu et al. (2010b) also reported. Bali and Cakici (2010) also computed the average correlations of stock returns with global market portfolio returns, finding that average correlations varied over time, although market integration did not increase. Instead, there was partial integration that varied over time. An and Brown (2010) investigated the co-movements of the stock market index returns for Brazil, Russia, India, the U.S. and China using weekly and monthly return data from October 1995 to October 2009. They found cointegration between the U.S. and China but none between emerging markets and the U.S. Thus, except for China, BRIC (Brazil, Russia, India and China) stock markets can still benefit from international diversification.

2.2. Time-varying Return Correlations

This study draws important inferences for international diversification and international portfolio management by examining the correlation structures among local industries or local countries. Therefore, it is necessary to first review studies of these correlations. Ferreira and Gama (2010) reported important empirical findings for portfolio selection and risk management regarding global industry correlations. Correlation is an important measure of portfolio value at risk. If correlations change, the number of industries required for adequate diversification also changes over time. They characterized the correlation dynamics of global industry portfolios regarding long-term trends and asymmetries using a time-varying correlation measure called realized correlations. They used daily index return data to constitute a correlation time series based on monthly frequency in each month by applying several econometric models. Specifically, they examined time-series behavior and asymmetries in terms of the correlations of global industry with the world market portfolio for 42 sectors in ten industries based on the FTSE/Dow Jones Industry Classification for January 1979 through December 2008. Time-varying correlation estimates were used to examine the asymmetries corresponding with the aggregate market up and down movements for global industry groups.

Regarding global industrial sectors, Ferreira and Gama (2010) showed that oil and gas have the lowest correlations whereas industrials has the highest, although these correlations change over time. For instance, there is a decrease in correlations in the late 1990s, apart from the technology sector. Apart from the telecommunications and financial sector correlations, which significantly increased, industry correlations moved countercyclically. Also, global industry correlations were higher for market downside than upside moves.

Dutt and Mihov (2013) used pair-wise returns correlations to investigate correlations with respect to risk-adjusted differences across 58 countries using monthly stock market indexes for 1970-2006. They established industrial similarity from industry production data. They investigated whether co-movements between stock market returns depend on similarities or differences. The regressions were run with control variables to control for pair-specific, country-specific and time-specific fixed effects. They calculated the variance-covariance matrix of global shocks based on sector and determined the risk-adjusted production structure differences using the method of Koren and Tenreyro (2007). They concluded that countries with smaller risk-adjusted differences in production structure also have similar stock market return movements.

Dutt and Mihov (2013) calculated conditional correlations using two asset pricing models and the residuals. The Fama-French model (Fama and French 1996, 1998) and an international and regional Capital Asset Pricing Model (CAPM) (Bekaert and Harvey 1995, 1997) were used to investigate, respectively, co-movements due to stock styles and co-movements due to variations in the world and regional integration. The conclusion was that countries with similar risk-adjusted production structures have higher conditional correlations. The findings remained robust after controlling for differences between country pairs.

Erb et al. (1994) used semi-correlation analysis with a sample from January 1970 to December 1993 to examine whether correlations differ if the data is segmented by ex-post returns. They also constructed a semi-variance measure in the same way. The semi-correlation analysis enables the prediction of equity correlations. Variations in correlations are important for forecasting future correlations. Thus, this study tried to forecast correlations by constructing models. The variables included expected economic activity, expected stock returns and persistence in correlations. In asset allocation analysis, the forecasted correlations (instead of historical measures) changed the weights of global asset allocation and domestic portfolio decisions between stocks and bonds. This exploration affected the valuation of derivative securities. The analysis tested the hypothesis that correlations can be estimated with variables measuring returns and persistence of volatility, the differential in expected returns and the expected business cycle in two countries. This made much of the variability in the correlations predictable.

2.3. The Capital Asset Pricing Model and its Implications

Correlations are estimated through asset pricing models before investigating the relationship between correlations and returns. Since the early 1960s, CAPM has been an important model for pricing risky assets in financial markets. The model has been extended by many researchers, including Sharpe (1964), Mossin (1966), Lintner (1965, 1969), Black (1972), Merton (1973), Ross (1976), Fama and French (1993) and Fama and French (2015). One of the earliest studies using CAPM is a two-parameter empirical investigation by Fama and MacBeth (1973: 607). They applied time series and cross-sectional regression analyses to the monthly return rates of all stocks trading on the New York Stock Exchange between January 1926 and June 1968 to explore the relationship between stock returns and risk. Since then, the approach of Fama and Macbeth (1973) has been used in many studies examining particular cross-sectional relations (e.g. Foster, 1978; Fama and French, 1989; Jagannathan and Wang, 1998; Pontiff and Woodgate, 2008; Kamstra, 2017; Zaremba et al., 2019;). Black et al. (1972) performed one of the first tests of CAPM. Beta values are estimated using monthly data for all stocks listed on the New York Stock Exchange for 1926-1965. This time period was divided into sub-periods with portfolios created within each. They found a significant linear relationship between the rate of return and betas (In contrast, Fama and MacBeth (1973) estimated return values for the following periods and beta values obtained from the previous periods. According to MPT, investors can construct optimal portfolios given the maximum possible expected return for a given level of risk (Markowitz, 1952: 77). CAPM extends this with a general equilibrium model that explains investors' expectations of returns on risky assets (Fama and French, 1993: 7).

Black (1972) demonstrated that borrowing restrictions, including margin rules, bankruptcy laws and tax rules, may cause low-beta stocks to have higher expected returns than CAPM states. They developed a model implying a flatter security market line, which was related to expected return while the beta was positive. Frazzini and Pedersen (2014) extended the insight of Black (1972) by generating a model that included a broader set of constraints, a time-series and cross-sectional properties.

Fletcher (2000) and Tang and Shum (2003) used country-level index data to demonstrate a significant conditional relationship between index returns and a world market beta. However, there is a difference between their studies. Fletcher (2000) used a CAPM that assumed full integration and ignored country-specific idiosyncratic risk whereas Tang and Shum (2003) only considered exchange rate risk as a country-specific risk. Hueng (2014) analyzed partial integration using an International Capital Asset Pricing Model (ICAPM) that included both world beta and country-specific idiosyncratic risks. He also determined the significance of the country-specific risk effects on international equity returns.

2.4. Relationship between Correlation and Return

This study also investigates the relationship between correlation and return using local industry and local country indexes. Regarding previous research, Asness et al. (2020) investigated the relationships between market beta, idiosyncratic volatility and maximum daily returns to identify which CAPM limitations explain the low-risk effect. They argued that, under limited rationality investor and short-sale conditions and leverage constraints, the systematic risk may be negatively priced. They, therefore, constructed a betting against beta (BAB) factor, which they decomposed into two sub-factors: betting against correlation (BAC) and betting against volatility (BAV). The factors were portfolios in each country, constructed by ranking stocks based on volatility and correlation. The BAC factor is the equal-weighted average of betting against correlation factors, just like the BAB factor. BAC goes long stocks with low correlation to the market and shorts stocks with high correlation while trying to match the volatility of bought and sold stocks. This removes the effect of volatility from beta. Implied correlations were then derived from a single-factor model after estimating sample correlations, which only holds just for a single-factor model like CAPM. Therefore, implied correlations should be derived from a multi-factor model after estimating sample correlations, which this study empirically demonstrated. On the other hand, BAV goes long and short depending on volatility. According to the theory of leverage constraints, BAC provides positive risk-adjusted returns because stocks with low market correlations have low market betas. The findings showed that BAC is as profitable as BAB while BAC has a significant CAPM alpha, which is consistent with the theory of leverage constraints. The study demonstrated significant alphas for both BAB and BAC under various combinations of control factors in the U.S. and globally. They concluded that the correlation between stock return and the market return is related to average return and consistent with borrowing constraints.

Frazzini and Pedersen (2014) constituted a BAB factor that goes long a portfolio of leveraged low-beta assets and short a portfolio of high-beta assets. That is, it is a portfolio holding low-beta and high-beta assets by sorting them based on their beta value. BAB provides the excess return on a portfolio. They tested the model on a sample of 55,600 stocks and international equities from 20 countries and the U.S. Stock return data were downloaded from the Center for Research in Security Prices tape and the Xpressfeed Global database. The time period for the Research in Security Prices ran from January 1926 to March 2012 while that for the Xpressfeed Global daily security file ran from January 1989 to March 2012. They found that high-betas and low-alphas are associated while BAB produces positive risk-adjusted returns, although returns are low when constraints are tightened. Liu et al. (2018) re-examined BAB's performance in the U.S. stock market according to Frazzini and Pedersan (2014), specifically the beta-idiosyncratic volatility relationship. They demonstrated that the hedging error variance ratio is approximately equal to the mean squared error based on the truly realized beta plus a term that was unrelated to the beta estimation.

Lu and Qin (2018) calculated the shadow cost of leverage constraints and investigated its pricing implications using leveraged funds for 2006-2016. The average annual shadow cost was 0.51%. It positively estimated BAB returns and negatively correlated with BAB returns. Underperforming stocks had 0.75% more return per month if the shadow cost increased. The BAB portfolio introduced by Frazzini and Pedersen (2014) is a zero-investment portfolio that goes long in low beta stocks and shorts high beta stocks, and has a zero CAPM beta. Zaremba (2018) investigated the returns on the BAB and SMB factor portfolios in 24 developed markets for 1989-2018. There was a strong relationship between the short-term, small-firm premium and future low-beta performance. Changing small firm prices changes funding conditions and short-run returns for the low-beta strategy. Using the time series of individual country returns, the study showed that SMB returns predict BAB performance. Hedegaard (2018) empirically verified the leverage aversion theory, which implies that returns to BAB strategy are predicted by past market returns. The author showed that the BAB strategy performs better if past market returns were high. The portfolios were constructed based on timing-strategies with a BAB factor. Daily and monthly BAB returns started in 1931 for the U.S. market and 988 for the other 23 countries. SML and HML factors of Fama and French (1993) and the UMD factor of Carhart (1997) were also used for the BAB-portfolios. The study showed that, by using past market returns, the timing strategies achieved strong historical performance.

Finally, Pollet and Wilson (2010) used quarterly data from 1963 to 2004 to show that average correlations between stock returns predict market returns. Moreover, there was a positive relationship between average stock correlation and future market return.

CHAPTER 3
TIME-SERIES BEHAVIOR OF CORRELATIONS AMONG INDUSTRIES OR COUNTRIES

3.1. Introduction

Since the theoretical models of portfolio selection developed by Markowitz, diversification has been considered the most effective risk reduction method unless assets or portfolios are perfectly positively correlated. Many investors have therefore attempted to diversify portfolio risk by investing in different national stock markets. Domestic and foreign macroeconomic factors significantly impact corresponding conditional correlations (Syllignakis and Kouretas, 2011: 717). For example, according to Ang and Bekaert (1999) and Longin and Solnik (1995, 2001), correlations between market returns almost always decline in bull markets and rise in bear markets while international stock market correlation is higher when markets are volatile.

The correlation structure among assets critically determines the effectiveness of portfolio diversification. This chapter applies several methods to calculate average correlations among international assets and compare the evolution of average correlations for several international asset groups. For this purpose, two sets of indexes are used to estimate the correlations: local industry indexes and local country indexes. This enables a more inclusive analysis of international diversification opportunities. Correlation coefficients are analyzed based on these indexes over time to show whether international diversification can reduce risk. If correlations do not significantly rise over time, international diversification can still be applied. If international diversification is still beneficial, then the next question is whether more diversification is made more effective by diversifying across local industries or countries. Accordingly, this chapter considers both local industry and local country indexes. The answer to this question indicates which diversification strategy international investors should adopt.

The correlations analyzed in this chapter are calculated in four ways: pair-wise correlations, correlations against global market return, implied correlations from asset pricing models and idiosyncratic correlations measured as the ratio of the difference between sample covariance and systematic covariance to the product of asset volatilities. In pair-wise correlation analysis, the correlations of the returns on local industries are calculated using the traditional parametric method. More specifically, pair-wise correlations between each pair of indexes are calculated for each month using daily return data within a month. Then, the cross-sectional averages of pair-wise correlations are calculated in a month to obtain a time series of the average monthly correlations. Similar analyses are also performed for the local country indexes. To analyze the correlations against global market return, the correlations between return on local industries and return on the global market are calculated for each month. Then, cross-sectional averages of correlation coefficients against global market return are computed for each month in the research period. Similar analyses are applied to the local country indexes. To analyze implied correlations from asset pricing models, correlation coefficients are derived from three asset pricing models: a single-factor model, the FF3F model and the regional version of the FF3F model with three regional and three global factors, amounting to a total of six factors. In asset pricing models, the correlation coefficient between two assets can be expressed implicitly as a function of their sensitivities to systematic global and local factors. Researchers use different factor models and different factors depending on market segmentation and market integration theories. Therefore, the correlations are estimated with different factor models. For example, according to market segmentation theory, only local factors within a national market influence asset returns whereas, according to market integration theory, only global factors within the global market influence asset returns (Chakravarty et al., 1998: 328). The asset pricing model with a single factor and the FF3F model both include global factors whereas the regional asset-pricing model with six factors includes both global and local factors. Therefore, regression coefficients (betas) from the asset pricing models are used to calculate the pair-wise correlations between index returns before calculating average pair-wise correlations for each month. Implied correlations are estimated both for local industry and local country indexes. The only exception for this practice is the estimation of implied correlations from the regional asset-pricing model with six factors for country indexes. Since there is insufficient local country index data for each region to explain the correlations, the regional asset-pricing model with six factors is only applied to each region's local industry indexes. To analyze idiosyncratic correlations, which are implied by the difference between sample covariance and systematic covariance, the correlations of the returns on local industries are calculated based on the analyses of pair-wise and implied correlations from the asset pricing models. Idiosyncratic covariance is the difference between the covariance derived from pair-wise analysis and covariance derived from analysis of implied correlations from the asset pricing models. Monthly average idiosyncratic correlation coefficients are estimated for each month in the research period. After using the four methods to estimate monthly average correlations, unit root tests are run to investigate whether the average correlations are stationary or not. If markets are converging to full integration, then average correlations should increase over time and should not remain stationary. In this case, international diversification does not reduce risk. Conversely, if markets are not integrating progressively, then average correlations do not increase over time, so international diversification may still be advantageous. After determining the stationarity of the average correlations, mean difference tests are run to investigate the differences between the mean correlations of the two sets of indexes. Firstly, the differences between the mean correlations of return on local industries and local countries from the same country groups are compared. Then, the differences between the mean correlations of the same indexes from developed and emerging markets are compared. The whole process for all countries included in this chapter is repeated for developed and emerging countries. Thus, the results apply to the trading strategies of international investors. The results from the samples of local industry and local country indexes also indicate whether diversification is more effective across countries or industries. The remainder of the chapter is organized as follows. Section 3.2 introduces the data and background information. Section 3.3 presents the methodology, specifically the correlation analyses, unit root tests and mean difference tests, while Section 3.4 discusses the findings from these analyses and tests. Section 3.5 draws some conclusions from these findings.

3.2. Data

The data set contains country indexes and industry indexes from 37 countries. Daily return data of 19 local industry indexes belonging to each country, 37 local country indexes and the global index are downloaded from Thomson Reuters Datastream.

Daily return data of local industry and local country indexes and the global index are used to perform correlation analyses for the 511-months period from January 1973 to July 2015 in this chapter. Local industry and local country index returns are also used as dependent variables whereas global index returns are used as an independent variable in the asset pricing models to calculate the correlations. Daily Fama-French three factors are also used as independent variables from July 1990 when these factors became available for the first time. Therefore, implied correlations from the FF3F model are calculated over 301 months, starting from July 1990 and ending in July 2015. Four regions are used to analyze the correlations implied from regional models including both local and regional factors (Fama-French three factors). Daily Fama-French three factors are downloaded from Kenneth R. French Data Library.

Table 3.1. Descriptive Statistics for Local Industry Indexes

Industries	Mean	Standard Deviation	Industries	Mean	Standard Deviation
Automobiles and parts	0.013	0.127	Media	0.013	0.122
Banks	0.012	0.102	Oil and gas	0.013	0.112
Basic resources	0.014	0.120	Personal and household goods	0.018	0.171
Chemicals	0.013	0.115	Real estate	0.013	0.113
Construction and materials	0.012	0.103	Retail	0.015	0.100
Financial services	0.014	0.121	Technology	0.015	0.127
Food and beverage	0.013	0.089	Telecommunications	0.012	0.105
Health care	0.014	0.093	Travel and leisure	0.013	0.114
Industrial goods and services	0.014	0.100	Utilities	0.012	0.090
Insurance	0.015	0.109			

Table 3.2. Descriptive Statistics for Local Country Indexes from Developed and Emerging Countries

Developed Countries			Emerging Countries		
Countries	Mean	Standard Deviation	Countries	Mean	Standard Deviation
Australia	0.011	0.071	Argentina	0.009	0.093
Austria	0.009	0.067	Brazil	0.012	0.102
Belgium	0.011	0.058	Chile	0.013	0.067
Canada	0.009	0.055	China	0.015	0.102
Denmark	0.012	0.059	India	0.013	0.105
Finland	0.011	0.086	Korea	0.011	0.104
France	0.012	0.067	Malaysia	0.012	0.083
Germany	0.010	0.060	Mexico	0.015	0.084
Greece	0.007	0.107	Philippine	0.012	0.086
Hong Kong	0.014	0.099	Poland	0.007	0.106
Ireland	0.012	0.071	S. Africa	0.013	0.083
Italy	0.009	0.076	Taiwan	0.009	0.103
Japan	0.008	0.062	Thailand	0.015	0.104
Netherland	0.011	0.056	Turkey	0.019	0.159
New Zealand	0.009	0.063			
Norway	0.012	0.080			
Portugal	0.005	0.064			
Singapore	0.010	0.083			
Spain	0.010	0.068			
Sweden	0.014	0.073			
Switzerland	0.011	0.052			
The U.K.	0.011	0.063			
The U.S.	0.009	0.046			

Local industry indexes generate local country indexes and; local country indexes generate global market indexes. There are 19 local industry indexes of each local country index. Industry classification is based on Industry Classification Benchmark (ICB) which is operated and managed by FTSE Group[1].

Investors and other market participants utilize the global economy systematically with an industry classification system. The ICB is used to follow the performance and evolution of industries, supersectors, sectors and subsectors. According to the classification on the ICB, companies are separated into subsectors according to their main activity. Subsectors are grouped into sectors. The sectors are constituted as supersectors to determine some economic opportunities for investors. Then, supersectors are formed groups by industries (Umutlu, 2015: 62).

Supersector classifications on the ICB are used for 37 countries in this chapter. Industry indexes are shown in Table 3.1 (Umutlu, 2015: 63). Datastream does not present all local supersector indexes for some countries. Thus, 399 supersectors indexes are obtained for 37 countries. Country index returns are also compiled by Datastream. While 23 of 37 countries are developed countries, the remaining 14 countries are emerging countries as seen in Table 3.2. Each country has country indexes consisting of industries mentioned as local supersector indexes. Four regions used in the study are the European Region, the Japanese Region, the Asia-Pacific Region and the North American Region. The European Region includes Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherland, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, Poland and Turkey. The Japanese Region includes Japan. The Asia-Pacific Region includes Australia, Hong Kong, New Zealand, Singapore, China, India, Korea, Malaysia, Philippine, South Africa, Taiwan and Thailand. The North American Region includes the United States and Canada. Since there is not a developed market in the South American Region, three factors of this region do not exist in Kenneth R. French Data Library. The South American Region is not included in the region classification. Since the amount of local country index data in a region is not enough to explain the correlations, regional analyses are just applied for local industry indexes of each region.

Table 3.1 demonstrates the means and standard deviations of daily returns for 19 supersector indexes of 23 developed and 14 emerging markets. The values in Table 3.1 are obtained in the following steps: the basic statistics are calculated for local

[1] For more details about the ICB, see www.ftserussell.com.

supersector indexes. Time-series data is used for each country whose local supersector index is obtained by Datastream. The cross-sectional averages of the time-series statistics are calculated for each supersector index across countries. Table 3.2 represents the time-series information for the means and standard deviations for 37 local stock market indexes. The research period is from January 1973 to July 2015 for both series. However, the data period is from July 1990 to July 2015 for Fama-French three factors.

3.3. Methodology

3.3.1. Correlation Analyses

3.3.1.1. Pair-wise Correlation Analysis

The daily return data set is divided into months. If an index is never traded on any day within a month, that index is eliminated for this month. Equation (3.1) is used to calculate the correlation coefficient between two indexes.

$$\rho_{ij,pair-wise} = \frac{\sigma_{ij}}{\sigma_i \sigma_j} \tag{3.1}$$

where "$\rho_{ij,pair-wise}$" is the return correlation coefficient between country or industry index "i" and "j", "σ_{ij}" is the covariance between indexes "i" and "j", "σ_i" is the standard deviation of index "i" and "σ_j" is the standard deviation of index "j".

The pair-wise correlations of the returns for local industries or countries are calculated using daily data within a month. Thus, pair-wise correlations between each pair of indexes are calculated for each month. Then the average of all independent pair-wise correlations in a month is calculated to obtain the average monthly correlation measure. The average correlation for each month is calculated by dividing the sum of correlation coefficients by the number of correlation combinations (NCC) as defined in Equation (3.2).

$$NCC = \frac{n*(n-1)}{2} \tag{3.2}$$

where "n" is the number of indexes within a month. Equation (3.2) is used to calculate the number of correlation combinations between index returns. Thus, NCC shows the number of elements in the lower triangle of the correlation matrix except for the diagonal elements, which are all one. This process is applied for 511 months and 511 average correlation coefficients are calculated both for industry and country indexes separately.

3.3.1.2. Correlations against Global Market Return

The daily returns on local industry, country and global market indexes are divided into months. Return correlation between a local index and the global market index is calculated using daily returns within a month. The average of the correlations between local indexes and the global market index is calculated to obtain the monthly average correlation. The number of correlation combinations in a month is equal to the number of local indexes existing in that month. In the end, 511 average monthly correlation estimates are obtained.

Equation (3.3) is used to calculate correlation coefficients.

$$\rho_{im} = \frac{\sigma_{im}}{\sigma_i \sigma_m} \tag{3.3}$$

where "ρ_{im}" is the correlation coefficient between the return on a local index "i" and the return on the global market "m", "σ_{im}" is the covariance between the local industry/country "i" and the global market "m" and "σ_m" is the standard deviation of the global market "m". The other variables are as defined before.

3.3.1.3. Implied Correlations from Asset Pricing Models

It is possible to calculate the systematic correlations with respect to an asset pricing model. Implied correlations are derived from some asset pricing models based on some factors. Different factors are used in alternative asset-pricing models accounting for market segmentation and integration theories in the literature. The alternative models used are a single-factor model, the FF3F model and the regional asset-pricing model with six factors.

Local factors affect asset returns in segmented markets whereas global factors affect asset returns in integrated markets (Chakravarty et al., 1998: 328). The asset pricing model with a single factor and the FF3F model have only global factors. These models work based on market integration theory. The regional asset-pricing model with six factors has both global and local factors. Thus, this model works more representative of the real world.

Markets can be strictly segmented or perfectly integrated according to some asset pricing models. Since a single-factor model and the FF3F model focus on global factors, they assume that markets are perfectly integrated. Global factors capture a degree of market integration (Arouri and Foulquier, 2012: 385). They are more restrictive models as compared to the regional asset-pricing model with six factors. However, the regional asset-pricing model with six factors is used for partially integrated markets.

If some investors do not hold all international assets because they prefer local assets based on segmentation, the world market portfolio is not effective. The asset pricing model with a single factor must be augmented by a new factor reflecting the local risk (Arouri and Foulquier, 2012: 385). In this chapter, local factors of four regions are also used to perform the analyses more comprehensively.

3.3.1.3.1. A Single-Factor Model

Correlation coefficients can be derived from asset pricing models. In this section, the correlations are expressed as a function of the beta. The beta as a forecaster of the correlations is estimated via a simple regression. Consider the simple regression model as shown in Equation (3.4).

$$R_{it} = \alpha_i + \beta_i R_{Mt} + \varepsilon_{it} \tag{3.4}$$

where "R_{it}" indicates the daily excess return on local industry/country "i" on day "t" within month "T", "R_{Mt}" indicates the daily excess return on the global market, "α_i" indicates the intercept term, "β_i" -beta- indicates the regression coefficient which will also be used to calculate the correlation coefficient between the return on the global market and the return on the local industry/country "i". "ε_{it}" indicates the error term.

Simple regression which is stated in Equation (3.4) represents the global version of the CAPM. The correlations between the return on the global market and the return on each local industry/country are analyzed within each month. This means that one beta is estimated for one local industry/country within a month. The beta estimates from Equation (3.4) are used in Equation (3.5) to calculate the correlation coefficients. Equation (3.5) is derived from Equation (3.1).

$$\rho_{ij,single\ factor} = \frac{\beta_i \beta_j \sigma_m^2}{\sigma_i \sigma_j} \tag{3.5}$$

where "$\rho_{ij,single\ factor}$" indicates the correlation coefficient between the local industry/country "i" and "j", "σ_m^2" indicates the variance of the global market index. "$\beta_i \beta_j \sigma_m^2$" is the covariance of returns between the local industry/country "i" and "j".

After the pair-wise correlations between the return on local industries/countries are estimated within a month, the analyses continue as the process for Equation (3.1). The pair-wise correlations of the returns on local industries/countries are calculated using daily data within a month. Thus, pair-wise correlations between each pair of indexes are calculated for each month. Correlation estimates are generated for each month. The only difference between the process of Equation (3.1) and Equation (3.5) is that beta is estimated from a simple regression model and used in Equation (3.5) to calculate correlation coefficients.

Elton et al. (1978) told about some models forecasting the correlation structure between securities. Some of the models are based on estimating the beta. According to Equation (3.5), the correlations among the returns on local industries/countries are calculated based on the betas. The betas have already been estimated, therefore the correlations implied from the asset pricing model are calculated for each month.

Markowitz (1952) found MPT and interpreted the risk and return trade-off. CAPM is based on the portfolio theory of Markowitz and is developed by Sharpe (1964), Lintner (1965) and Mossin (1966) independently (Goren and Umutlu, 2015: 609). CAPM is a model that shows the relationship between the expected return and the risk level of an asset (Gökbel, 2003: 21-22). It is assumed that all investors have the same expectations and all securities which exist in the market are treated (Elton and Gruber, 1999: 295).

One of the methods to estimate the beta is Equation (3.4). Another method is demonstrated in Equation (3.6).

$$\beta_i = \frac{\sigma_{im}}{\sigma_m^2} \tag{3.6}$$

The variables are previously defined. The covariance between the returns on local industries/countries and the return on the global market should be calculated in Equation (3.6) to estimate the beta.

3.3.1.3.2. The FF3F Model

Fama and French (1993) developed the FF3F model that is an extension of CAPM. Size risk, value risk and the market risk factors are used in the model (Al-Mwalla and Karasneh, 2011: 132). The size factor is the outperformance of small-cap companies relative to large-cap companies and the value factor is the outperformance of high book-to-market companies versus low book-to-market companies. Fama and French consider that small-cap and high-value companies tend to outperform the markets regularly (Fama and French, 1993: 12). The FF3F model showed that CAPM performed poorly in explaining returns. The three-factor model has more explanatory power than a single-factor CAPM (Gaunt, 2004: 28).

In this section, the FF3F model is also used to calculate correlations. The correlations are expressed as a function of betas based on three factors. The global factors which are used in regressions are market risk factor ($\mathrm{R_M}$), Small Minus Big (SMB) factor and High Minus Low (HML) factor. They are shown in Equation (3.7).

$$R_{it} = \alpha_i + \beta_{i1} R_{M_t} + \beta_{i2} SMB_t + \beta_{i3} HML_t + \varepsilon_{it} \tag{3.7}$$

where "β_{i1}" -beta- indicates the factor coefficient of the return on the global market, "β_{i2}" -beta- indicates the factor coefficient of SMB. "SMB_t" is the difference in returns on small firms and large firms and represents the size effect depending on a market capitalization of a company. "β_{i3}" -beta- indicates the factor coefficient of HML. "HML_t" is the difference in returns of firms with high book-to-market value ratios and the returns of firms with low book-to-market value ratios. The other variables are as defined before.

Small-cap companies tend to see higher returns than big-cap companies in the long-term. The value companies (high book-to-market ratio) gain pleasure from higher returns than growth companies (low book-to-market ratio) in the long-term (Fama and French, 1993: 19).

Beta coefficients can be determined by linear regression. If three factors are correlated with each other, this can cause a multicollinearity problem. The correlation between factors may be removed by the orthogonalization process. Each factor is orthogonalized (i.e. uncorrelated) with respect to other factors by running Equation (3.8) and Equation (3.9). Orthogonalization is an econometrical technique that makes factors uncorrelated with each other. At the end of this process, the covariance and correlation between factors become zero.

$$R_{SMB_t} = \alpha_i + \beta_{iM} R_{M_t} + \varepsilon_{SMB_t} \tag{3.8}$$

where "R_{SMB_t}" indicates the daily return on a portfolio of SMB on day "t" within month "T", "β_{iM}" -beta- indicates the factor coefficient of the return on the global market and "ε_{SMB_t}" indicates regression residual of the SMB factor (orthogonalized SMB).

$$R_{HML_t} = \alpha_i + \beta_{iM} R_{M_t} + \beta_{iSMB} \varepsilon_{SMB_t} + \varepsilon_{HML_t} \tag{3.9}$$

where "R_{HML_t}" indicates the daily return on a portfolio of HML on day "t" within month "T", "β_{iSMB}" indicates the factor coefficient of orthogonalized SMB and "ε_{HML_t}" indicates regression residual of the HML factor (orthogonalized HML).

At the end of two steps (Equation (3.8) and Equation (3.9)), daily ε_{SMB} and ε_{HML} are constructed for each month. Then, the orthogonal factors are brought in Equation (3.10) which derives from Equation (3.7). Each local industry/country index is simultaneously regressed on three factors and the monthly betas are obtained for each local industry/country index.

$$R_{it} = \alpha_i + \beta_{i1} R_{M_t} + \beta_{i2} \varepsilon_{SMB_t} + \beta_{i3} \varepsilon_{HML_t} + \varepsilon_{it} \tag{3.10}$$

where "β_{i1}" -beta- indicates the factor coefficient of the return on the global market, "β_{i2}" -beta- indicates the factor coefficient of orthogonalized SMB and "β_{i3}" -beta- indicates the factor coefficient of orthogonalized HML.

After index-level regressions are performed, implied correlations from the FF3F model are obtained. The Equation (3.11) and Equation (3.12) hold when R_M, SMB and HML factors are orthogonal. Betas which are obtained from Equation (3.10) are used in Equation (3.11) and Equation (3.12).

$$\sigma_{ij} = \beta_{i1}\beta_{j1}\sigma_m^2 + \beta_{i2}\beta_{j2}\sigma_{\varepsilon_{SMB}}^2 + \beta_{i3}\beta_{j3}\sigma_{\varepsilon_{HML}}^2 \tag{3.11}$$

where "β_{j1}" indicates the sensitivity of the return on local industry/country "j" to the return on the global market, "β_{j2}" indicates the sensitivity of the return on local industry/country "j" to the return on orthogonalized SMB, "$\sigma_{\varepsilon_{SMB}}^2$" indicates the variance of orthogonalized SMB, "β_{j3}" indicates the sensitivity of the return on local industry/country "j" to the return on orthogonalized HML and "$\sigma_{\varepsilon_{HML}}^2$" indicates the variance of orthogonalized HML.

$$\rho_{ij,FF3F} = \frac{\beta_{i1}\beta_{j1}\sigma_m^2 + \beta_{i2}\beta_{j2}\sigma_{\varepsilon_{SMB}}^2 + \beta_{i3}\beta_{j3}\sigma_{\varepsilon_{HML}}^2}{\sigma_i \sigma_j} \tag{3.12}$$

where "$\rho_{ij,FF3F}$" indicates the correlation coefficient between the local industry/country "i" and "j", "σ_i" indicates the standard deviation of the local industry/country "i" and "σ_j" indicates the standard deviation of the local industry/country "*j*". The numerator of fraction in Equation (3.12) is the covariance of returns between the local industry/country "i" and "j" and; is defined above.

Average correlation coefficients for the return on local industries/countries are calculated using daily data within Equation (3.11) and Equation (3.12). Implied correlations from the FF3F model will also be used to calculate idiosyncratic correlations.

3.3.1.3.3. The Regional Asset-Pricing Model with Six Factors

CAPM has been converted into the multi-factor model over the last few decades. Fama and French (1993) extended CAPM by adding two factors relating to book-to-market and size and; invent a three-factor model. The FF3F model becomes the benchmark model in cross-sectional asset returns (Roy and Shijin, 2018: 205).

The regional asset-pricing model with six factors is a more representative model for the real-world market as compared to a single-factor model and the FF3F model. A single-factor model is converted into the regional asset-pricing model with six factors by increasing the number of factors used in the model.

Many national stock markets should be between strict segmentation (in other words "zero integration") and perfect integration. Therefore, these markets are partially integrated. Estimating the degree of market integration is an empirical process within the context of an ICAPM (Arouri and Foulquier, 2012: 383).

The regional asset-pricing model with six factors is an econometric combination of an international and a national CAPM. The integration measure is modeled as a function of global and local factors. The model can be used for all markets or individual assets.

In this section, the regional asset-pricing model with six factors is used by adding local market risk factor (LM), Local Small Minus Big (LSMB) factor and Local High Minus Low (LHML) factor to the FF3F model. LM is the return on the market of a specific region. LSMB is the difference in returns on small firms and large firms in a specific region and is a size effect depending on a market capitalization of a company. LHML is the difference in returns of firms with high book-to-market value ratios and the returns of firms with low book-to-market value ratios in a specific region (Al-Mwalla and Karasneh, 2011: 133).

The local factors belong to four regions: the European Region, the Japanese Region, the Asia-Pacific Region and the North American Region. Three local factors of each region are added to global factors respectively. Therefore, the regional asset-pricing model with six factors is run for each region to explain the correlations of local industry indexes for this region. Since there is not a developed market in the South American Region, three factors of this region do not exist in Kenneth R. French Data Library. That's why the South American Region is not used in this section. Since the amount of local country index data in a region is not enough to explain the correlations, the regional asset-pricing model with six factors is just applied to local industry indexes of each region. Local factors are specific to four regions for the regional asset-pricing model with six factors. Therefore, the return of local industries within a region is affected by both local and global factors.

The regional asset-pricing model with six factors is also used to calculate correlations. The correlations are expressed as a function of betas based on six factors. The global factors that are used in regressions are $\mathrm{R_M}$, SMB and HML factors and local factors that are used in regressions are LM, LSMB and LHML factors.

Beta coefficients are estimated by linear regressions. Each factor is made orthogonal to the other factors by running Equation (3.13), Equation (3.14) and Equation (3.15) in order. Therefore, factors will be uncorrelated with each other.

$$R_{LM_t} = \alpha_i + \beta_{iM} R_{M_t} + \beta_{iSMB} \varepsilon_{SMB_t} + \beta_{iHML} \varepsilon_{HML_t} + \varepsilon_{LM_t} \quad (3.13)$$

$$R_{LSMB_t} = \alpha_i + \beta_{iM} R_{M_t} + \beta_{iSMB} \varepsilon_{SMB_t} + \beta_{iHML} \varepsilon_{HML_t} + \beta_{iLM} \varepsilon_{LM_t} + \varepsilon_{LSMB_t} \quad (3.14)$$

$$R_{LHML_t} = \alpha_i + \beta_{iM} R_{M_t} + \beta_{iSMB} \varepsilon_{SMB_t} + \beta_{iHML} \varepsilon_{HML_t} + \beta_{iLM} \varepsilon_{LM_t} + \beta_{iLSMB} \varepsilon_{LSMB_t} + \varepsilon_{LHML_t} \quad (3.15)$$

where "R_{LM_t}" indicates the daily return on the market of a specific region on day "t" within month "T", "R_{LSMB_t}" indicates the daily return on a portfolio of LSMB of a specific region, "R_{LHML_t}" indicates the daily return on a portfolio of LHML of a specific region, "β_{iLM}" -beta- indicates the factor coefficient of orthogonalized LM, "ε_{LM_t}" indicates the regression residual of the LM factor, "β_{iLSMB}" indicates the factor coefficient of orthogonalized LSMB, "ε_{LSMB_t}" indicates regression residual of the LSMB factor and "ε_{LHML_t}" indicates regression residual of the LHML factor. The other variables are as defined before.

At the end of three steps (Equation (3.13), Equation (3.14) and Equation (3.15)), daily ε_{LM}, ε_{LSMB} and ε_{LHML} of each region will be constructed for each month. After the orthogonalization of factors for each region is established by running Equation (3.13), Equation (3.14) and Equation (3.15), the orthogonal local factors are included in Equation (3.16) for a specific region. Three global factors have been already constructed in the section of the FF3F model. The value of each global factor is the same for all regions. However, the value of each local factor changes from region to region. Therefore, each local industry index of a specific region is regressed on six factors using daily data for each month. Betas are obtained for each local industry index of the region.

$$R_{it} = \alpha_i + \beta_{i1}R_{M_t} + \beta_{i2}\varepsilon_{SMB_t} + \beta_{i3}\varepsilon_{HML_t} + \beta_{i4}\varepsilon_{LM_t} + \beta_{i5}\varepsilon_{LSMB_t} + \beta_{i6}\varepsilon_{LHML_t} + \varepsilon_{it} \quad (3.16)$$

where "β_{i4}" -beta- indicates the factor coefficient of orthogonalized LM, "β_{i5}" -beta- indicates the factor coefficient of orthogonalized LSMB and "β_{i6}" -beta- indicates the factor coefficient of orthogonalized LHML. The other variables are previously defined.

After index-level regressions are performed, implied correlations from the regional asset-pricing model with six factors are obtained. The Equation (3.17) and Equation (3.18) hold when R_M, SMB, HML, LM, LSMB and LHML factors are orthogonal. Betas which are obtained from Equation (3.16) are used in Equation (3.17) and Equation (3.18).

$$\sigma_{ij} = \beta_{i1}\beta_{j1}\sigma_m^2 + \beta_{i2}\beta_{j2}\sigma_{\varepsilon_{SMB}}^2 + \beta_{i3}\beta_{j3}\sigma_{\varepsilon_{HML}}^2 + \beta_{i4}\beta_{j4}\sigma_{\varepsilon_{LM}}^2 + \beta_{i5}\beta_{j5}\sigma_{\varepsilon_{LSMB}}^2 + \beta_{i6}\beta_{j6}\sigma_{\varepsilon_{LHML}}^2 \quad (3.17)$$

where "β_{i4}" indicates the sensitivity of the return on local industry "i" to the return on orthogonalized LM, "β_{j4}" indicates the sensitivity of the return on local industry "j" to the return on orthogonalized LM, "$\sigma_{\varepsilon_{LM}}^2$" indicates the variance of orthogonalized LM, "β_{i5}" indicates the sensitivity of the return on local industry "i" to the return on orthogonalized LSMB, "β_{j5}" indicates the sensitivity of the return on local industry "j" to the return on orthogonalized LSMB, "$\sigma_{\varepsilon_{LSMB}}^2$" indicates the variance of orthogonalized LSMB, "β_{i6}" indicates the sensitivity of the return on local industry "i" to the return on orthogonalized LHML, "β_{j6}" indicates the sensitivity of the return on local industry "j" to the return on orthogonalized LHML and "$\sigma_{\varepsilon_{LHML}}^2$" indicates the variance of orthogonalized LHML.

$$\rho_{ij,6F} = \frac{\beta_{i1}\beta_{j1}\sigma_m^2 + \beta_{i2}\beta_{j2}\sigma_{\varepsilon_{SMB}}^2 + \beta_{i3}\beta_{j3}\sigma_{\varepsilon_{HML}}^2 + \beta_{i4}\beta_{j4}\sigma_{\varepsilon_{LM}}^2 + \beta_{i5}\beta_{j5}\sigma_{\varepsilon_{LSMB}}^2 + \beta_{i6}\beta_{j6}\sigma_{\varepsilon_{LHML}}^2}{\sigma_i\sigma_j} \quad (3.18)$$

where "$\rho_{ij,6F}$" indicates the correlation coefficient between the local industry "i" and "j". The numerator of fraction in Equation (3.18) is the covariance of returns between the local industry "i" and "j" and is explained above.

Average correlation coefficients for local industry indexes are calculated for a specific region using daily data within a month in Equation (3.17) and Equation (3.18). Implied correlations from the regional asset-pricing model with six factors will also be used to calculate idiosyncratic correlations.

3.3.1.4. Idiosyncratic Correlations

A linear factor model is formed from time-varying factor exposures: betas, time-varying factor volatilities and time-varying idiosyncratic volatilities (Bunzel and Vogelsang, 2005: 6).

Return correlations of local industry/country indexes are analyzed over time by decomposing them into betas, factors and idiosyncratic covariances. Pair-wise correlations and implied correlations from the asset pricing model are calculated and the findings are used in a linear factor model to estimate idiosyncratic correlations. The sample covariances of local country/industry indexes are decomposed into systematic and idiosyncratic covariances in this section. An idiosyncratic covariance is the difference between sample covariance and systematic covariance (Bekaert et al., 2009: 2597):

$$cov_{idiosyncratic,t} = cov_{sample,t} - cov_{systematic,t} \quad (3.19)$$

where "$cov_{sample,t}$" indicates the local industry/country indexes' covariances estimated by pair-wise correlation analyses, "$cov_{systematic,t}$" indicates the local industry/country indexes' covariances estimated by implied covariances from asset pricing models, "$cov_{idiosyncratic,t}$" indicates the residual covariances. "$cov_{sample,t}$" is defined by multiplying pair-wise correlations by standard deviations of local industry/country indexes and "$cov_{systematic,t}$" is defined by multiplying implied correlations by standard deviations of local industry/country indexes. "$cov_{systematic,t}$" is associated with the systematic factors. It is derived from betas for a single-factor model and; factors for the FF3F model and the regional asset-pricing model with six factors. Thus, different idiosyncratic covariances are calculated from the difference between sample covariances and different systematic covariances. The idiosyncratic covariance ($cov(e_{i1}, e_{i2})$) should be zero if the factor model fully identifies index return co-movements.

Betas induce short-term changes in correlations due to the globalization (Bekaert et al., 2009: 2597). Correlations of local industry/country indexes can increase because of increasing betas for global factors (Fratscher, 2002: 2). Covariances are decomposed into separate components with the model in Equation (3.19). Idiosyncratic correlation is computed by dividing "$cov_{idiosyncratic}$" by "$\sigma_i \sigma_j$". Covariances vary over time. All three types of covariances are estimated monthly.

3.3.2. Unit Root Tests

After average correlation estimates are obtained for each month separately for both the local industry and local country indexes, the results are used to investigate the time-series evolution of correlation measures. Augmented Dickey-Fuller (ADF) test is used to apply the unit root test.

It is necessary to find how the previous value of the time series affects the present value to determine the movement of the time series. Unit root tests are used to create the regression of the time series. In the literature, some tests are performed to understand the existence of unit root tests and examine the stationarity in time series. The ADF test which was presented by Dickey and Fuller (1979) is one of them. Three basic regression models of the ADF test are demonstrated below (Maddala and Wu, 1999: 632):

No constant and no trend: $\Delta y_t = (\beta\text{-}1)y_{t-1} + v_t$ (3.20)

Constant and no trend: $\Delta y_t = \alpha + (\beta\text{-}1)y_{t-1} + v_t$ (3.21)

Constant and trend: $\Delta y_t = \alpha + (\beta\text{-}1)y_{t-1} + \lambda_t + v_t$ (3.22)

A lag length should be chosen to run the test. Lagged differences as shown below are added to these models by the ADF (Tuna and Öztürk, 2016: 552):

No constant and no trend: $\Delta y_t = (\beta\text{-}1)y_{t-1} + \sum_{s=\perp}^{m} a_s \Delta y_{t-s} + v_t$ (3.23)

Constant and no trend: $\Delta y_t = \alpha + (\beta\text{-}1)y_{t-1} + \sum_{s=\perp}^{m} a_s \Delta y_{t-s} + v_t$ (3.24)

Constant and trend: $\Delta y_t = \alpha + (\beta\text{-}1)y_{t-1} + \lambda_t + \sum_{s=\perp}^{m} a_s \Delta y_{t-s} + v_t$ (3.25)

The hypothesis for the test is shown below (Yurdakul, 2000: 3):

$H_0 : \beta = 1$

$H_A : \beta < 1$

The null hypothesis states that the beta value is not statistically different from one. The alternative hypothesis states that the beta value is less than one. If the null hypothesis is rejected, then there is not a unit root in the time series and the time series is stationary. If the null hypothesis is not rejected, there is a unit root in the time series and the time series is not stationary or trend-stationary.

Eviews 7 program runs the test and produces test statistics in terms of t-statistic and probability which are obtained as a result of Equation (3.23) and Equation (3.24). The results are interpreted by examining the p-value. When the p-value is less than the significance level (1%, 5%, and 10%), the null hypothesis is rejected. It means that there is not a unit root in the time series. The time series is stationary. On the other hand, examining the t-statistic also gives the same results as the p-value. When the t-statistic is less than the standardized t-statistic values of the ADF, the null hypothesis is rejected. It means that there is not a unit root in the time series. The time series is stationary. The standardized t-statistic values of the ADF are shown in Table 3.3. The monthly results are also shown in graphical representation.

Table 3.3. Critical Values for Dickey-Fuller t-distribution

Critical values	Constant and no trend	Constant and trend	No constant and no trend
1% Level	-3.44302	-3.97626	-2.56956
5% Level	-2.86702	-3.41871	-1.94145
10% Level	-2.56975	-3.13188	-1.61628

Source: Rinat, A., & Kumar, M. A. (2013). Generating critical values of unit root tests. Research Journal of Mathematical and Statistical Sciences.

An empirical work that is based on time-series data assumes that the time series is stationary. Whether a time series includes a unit root is an important issue (Gujarati and Porter, 2003). If the value of "*(β-1)*" which is presented in Equation (3.20), Equation (3.21) and Equation (3.22) is not statistically different from zero, the null hypothesis of a unit root is not rejected (a non-stationarity situation). The equation represents a random walk model without a constant term (intercept). Therefore, the variance of "Y_t" is not stationary. On the other hand, if $(\beta\text{-}1) < 0$, the time series "Y_t" is stationary. It is important whether the estimated coefficient of Y_{t-1} in the equation is zero or not. In each model, the null hypothesis is $(\beta\text{-}1) = 0$ which means that there is a unit root and the time series is not stationary. The alternative hypothesis is that "$(\beta\text{-}1)$" is less than zero and means that the time series is stationary (Gujarati and Porter, 2003). If the null hypothesis is rejected, it means that "Y_t" is a stationary time series with zero mean in Equation (3.20); "Y_t" is stationary with nonzero mean in Equation (3.21) and "Y_t" is stationary around a deterministic trend in Equation (3.22). A unit root is tested by finding the correct specification of the ADF test regressions. The coefficient estimates from the regressions are determined by applying the correct version of the ADF test (Judge et al., 1982).

Critical values, which are used to test the null hypothesis, are different for every three models of the ADF test. Statistics for each equation are computed by dividing the estimated coefficient of "Y_{t-1}" in each model by its standard error. They are compared to critical values presented in Table 3.3. If the absolute value of the statistic is higher than the critical value for the ADF test, the null hypothesis is rejected and the time series is stationary. If it is not higher than the critical value, the null hypothesis is not rejected and the time series is not stationary (Davidson and MacKinnon, 1993).

When a time series is not stationary, the regression of the non-stationary time series on another non-stationary time series can produce a spurious regression. This regression problem can be overcome by making given time series stationary (Gujarati and Porter, 2003). Error term, "v_t", in Equation (3.20), Equation (3.21) and Equation (3.22) is assumed uncorrelated. However, Dickey and Fuller have developed the ADF test in the case; "v_t" is correlated. The test is conducted by augmenting Equation (3.20), Equation (3.21) and Equation (3.22) and; adding the lagged values of the dependent variable "Y_t". The number of lagged difference terms is often adjusted empirically. Therefore, "v_t" in Equation (3.23), Equation (3.24) and Equation (3.25) is uncorrelated. In the ADF test, whether $\beta = 1$ is tested and the same critical values are used.

In this chapter, two basic regression models of the ADF test are estimated by the model without a constant term and linear trend (Equation (3.20)) and the model with a constant term (Equation (3.21)). The second model is generated by adding a constant term to the first model. There is no constant term in Equation (3.20). This states that the process under the null hypothesis is a random walk without drift. Therefore, the time series is not stationary. This is not suitable for empirical work. Equation (3.21) is applied to obtain stationarity. The process under the null hypothesis becomes a random walk with nonzero drift by adding a constant term in Equation (3.20). On the other hand, Equation (3.22) indicates that a trend term is included in the regression.

If a unit root is detected for the model represented by Equation (3.21), applying Equation (3.22) will be necessary to reach stationarity. However, a unit root does not mostly exist for Equation (3.21). That's why Equation (3.22) is not used in this chapter. Besides, analyzing whether a constant term exists or not in the model is important to understand the time-series fluctuations around a constant. However, Equation (3.22) is not necessary to understand this because Equation (3.21) is applied. When a constant term is included in the basic regression model of the ADF test, the coefficients of the regressors do not vary over time. The intercept is determined based on a deviation from the constant mean value (Damodar, 2004).

3.3.3. Mean Difference Tests

Investigating the difference between means is more common than examining the absolute values of the means in the literature. The mean difference measures the absolute difference between the mean values in two different groups. It is determined how much difference exists between the average values of the experimental group and control groups (Hozo et al., 2005: 5).

There are some assumptions to test the difference between population means. Each value is independent of the other value in the sample. The sampling method is simple random sampling. Therefore, one value is just derived by each subject. Otherwise, values will not be independent. The sampling distribution is approximately normal. This condition is provided when the populations are normally distributed (Norušis, 2006: 271).

The hypotheses are defined and are mutually exclusive in this approach. It is required to state a null hypothesis and an alternative hypothesis. The hypotheses are stated across different forms based on the side of the sampling distribution (Easton and McColl, 2002). In this chapter, the hypothesis is defined below:

H_0: $\mu_1 = \mu_2$

H_A: $\mu_1 \neq \mu_2$

"μ_1" is the mean of one population and "μ_2" is the mean of another population. There is no difference between the two population means based on the null hypothesis. The alternative hypothesis states that there is a difference between the two population means. It is a two-tailed test (Easton and McColl, 2002).

Significance level and test method should be determined. Significance levels equal to 0.01, 0.05 and 0.1. The two-sample t-test is used to specify whether the mean difference is significantly different from the hypothesized difference between means. Test of significance is performed by the following equation (Norušis, 2006: 271):

$$t = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} \tag{3.26}$$

where "n_1" indicates the size of sample one, "n_2" indicates the size of sample two, "s_1" indicates the standard deviation of sample one, "s_2" indicates the standard deviation of sample two, "$\bar{x}_1$" indicates the mean of sample one, "$\bar{x}_2$" indicates the mean of sample two, "$\mu_1 - \mu_2$" indicates the hypothesized difference between population means.

The results are interpreted according to the null hypothesis. If the test value is in a critical region, the sample findings are unlikely. The null hypothesis is rejected. On the other hand, the null hypothesis is rejected when the p-value is less than the significance level. Rejecting the null hypothesis means that there is enough evidence to reject the null hypothesis.

3.4. Preliminary Results

The results of average correlation estimates are presented based on three samples consisting of local industry and local country indexes: i) the full sample (both developed and emerging countries), ii) developed countries, iii) emerging countries. Figures show the time-series behavior of monthly correlations of local industry and local country indexes through time. Interpreting the findings solely based on the visual inspection can lead to a lack of knowledge. Thus, the findings are expanded by more formal tests, i.e. unit root and mean difference tests. The results of the averages for each type of correlation are reported employing two models of the ADF test: i) the model without a constant term and linear trend ii) the model with a constant term. The ADF test is applied to examine the existence of unit-roots. Then, the findings of mean difference tests are presented to compare average correlations of local industry and local country indexes, and those of developed and emerging countries.

3.4.1. Results

Figures present the time-series behavior of average correlation estimates for visual inspection. Tables present the statistical results of time-series analyses of average correlation estimates. The null hypothesis of whether a unit root exists is tested. Therefore, the stationarity in time series is investigated. Test statistics are interpreted by examining statistics in each test based on the significance level and comparing the result to the t-statistic values.

The time-series averages for correlations of local industry indexes are depicted from Figure 3.1 to Figure 3.14 and those of local country indexes are included from Figure 3.15 to Figure 3.20. The results for pair-wise correlations, correlations against global market return, single-factor model implied correlations, the FF3F model implied correlations, idiosyncratic correlations from a single-factor model and idiosyncratic correlations from the FF3F model of local industry indexes are presented from Table 3.4 to Table 3.31 while those of local country indexes are shown from Table 3.32 to Table 3.43. The results of the regional asset-pricing model with six factors, which are presented only for local industry indexes, are shown from Table 3.12 to Table 3.19, and Table 3.24 to Table 3.31 based on implied and idiosyncratic correlations, respectively. Two models; i.e. the model without a constant term and linear trend, and the model with a constant term, are conducted for each type of correlation estimate. The results of two models are different for every correlation measure except for idiosyncratic correlations from the regional asset-pricing model with six factors. Mean difference test statistics of local industry and local country indexes are reported from Table 3.44 to Table 3.49.

3.4.1.1. Results for Local Industry Indexes

Figure 3.1 shows the average pair-wise correlations for local industry indexes for the full sample. The average correlations do not indicate a constantly positive or negative trend in the long run. They fluctuate considerably through time. The spikes in the time series of average correlations of local industry indexes are consistent with the crisis periods. The correlation is generally higher in some periods of the trading cycle, for instance, periods with high-interest rates and dividend yields (Longin and Solnik, 1995:

7). An increase in average correlations is an expected phenomenon at the crisis time. For instance, there is a spike in the time series in 1988 in Figure 3.1. It can be originated from Black Monday which occurred in October 1987 and tumbled down the world markets and local industries (Bogle, 2008: 30). The reason for deviations at the beginning of the series can be associated with Argentina's economic instability occurring at the end of 1989. It borrowed money from the International Monetary Fund and could not pay it back. As a result, the inflation level reached a 200% level (Schamis, 2002: 81). Therefore, many local countries and local industries are affected negatively. The Asian crisis in 1997 affected many countries negatively, especially Asia, and large-scale industries of Korea, Taiwan, Hong Kong and Southern China (Wade, 1998: 1536). On the other hand, the Dot-Com Bubble (Technology Bubble) can be the reason for the fluctuations in the correlation series between 1995 and 2001. Dot-com Bubble is a stock market bubble that occurred based on excessive speculation in technology companies and lost its effect in March 2000 by impairing of stock exchange index of technology companies in NASDAQ (Ljungqvist and Wilhelm, 2003: 723). After 2006, there is an overall increase for average correlations. The reason for the increase in average correlations can be due to the Subprime Mortgage Crisis which occurred in the United States in 2008. The crisis spread worldwide and affected negatively many local industries and local countries (Demyanyk and Van Hemert, 2009: 1848).

Figure 3.7 depicts average regional asset-pricing model implied correlations for local industry indexes from the Japanese Region. The average correlations fluctuate in the long-run. However, implied correlations of the Japanese Region are a little higher than other correlation types of local industry indexes for the full sample. Figure 3.10 demonstrates average idiosyncratic correlations from the FF3F model for local industry indexes. Some fluctiations seem remarkable between 2008 and 2009 and between 2013 and 2014. Figure 3.13 indicates average idiosyncratic correlations from the regional asset-pricing model for local industry indexes from the Japanese Region. There is a rise in the correlations between 1992 and 1996.

The figure results are quite consistent with several economic crises. That is, the time series of the average correlations fluctuate through time and have some jumps during economic depressions. Average correlations typically increase during economic crises and decrease during crisis-free times due to financial contagion. Moreover, international diversification still has benefits as average correlations do not increase through time as can be seen from the table results. Table 3.4 includes unit root test statistics based on the model without a constant term and linear trend for pair-wise correlations of local industry indexes for the full sample. This model examines the time series of average correlations without a constant term and trend stationarity. MEANINDCORR represents the average pair-wise correlations of local industry returns. According to the findings, the existence of the unit root hypothesis is not rejected at any significance level. There is a unit root and the time series is not stationary. Table 3.5 provides unit root test statistics based on the model with a constant term for pair-wise correlations of local industry indexes for the full sample. The findings of the model with a constant term show whether the time series of average correlations are stationary around a constant. As can be seen from Table 3.5, the unit root hypothesis testing the existence of a unit root is rejected at the significance level of 1% and the time series is stationary.

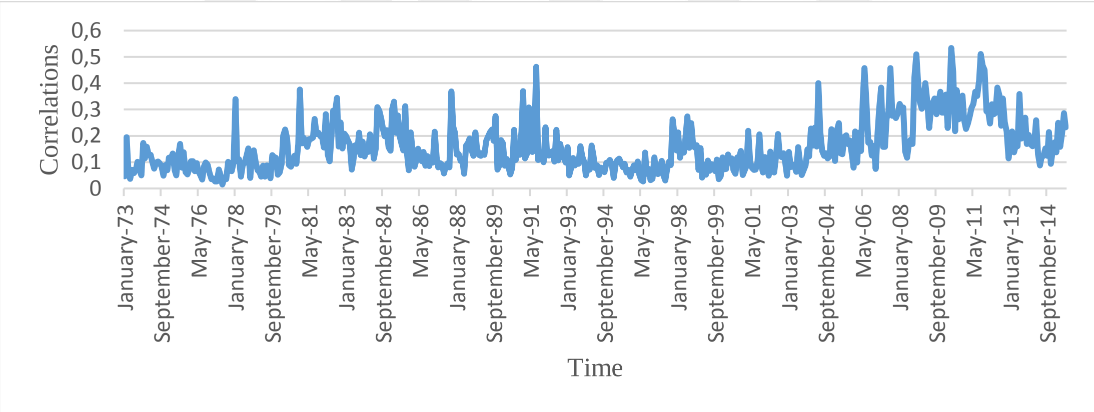

Figure 3.1. Average Pair-wise Correlations for Local Industry Indexes

Table 3.4. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for Pair-wise Correlations of Local Industry Indexes

Variable	Coefficient	t-Statistic	Prob.
MEANINDCORR(-1)	-0.019953	-1.187689	0.2355
D(MEANINDCORR(-1))	-0.532523	-11.45024	0.0000
D(MEANINDCORR(-2))	-0.423432	-8.262470	0.0000
D(MEANINDCORR(-3))	-0.328843	-6.153353	0.0000
D(MEANINDCORR(-4))	-0.232052	-4.372722	0.0000
D(MEANINDCORR(-5))	-0.208869	-4.163167	0.0000
D(MEANINDCORR(-6))	-0.134914	-3.034320	0.0025
The ADF Test Statistic		-1.187689	0.2151

Table 3.5. Unit Root Test Statistics based on the Model with a Constant Term for Pair-wise Correlations of Local Industry Indexes

Variable	Coefficient	t-Statistic	Prob.
MEANINDCORR(-1)	-0.168894	-4.689643	0.0000
D(MEANINDCORR(-1))	-0.373181	-7.484093	0.0000
D(MEANINDCORR(-2))	-0.253694	-5.171952	0.0000
D(MEANINDCORR(-3))	-0.139382	-3.165810	0.0016
The ADF Test Statistic		-4.689643	0.0001

For local industry indexes of the full sample, the results of further average correlations are provided from Table 3.6 to Table 3.31, and Figure 3.2 to Figure 3.14. The results of each type of average correlation are almost identical to the results of average pair-wise correlations for local industry indexes. According to the majority of results as seen in relevant tables, the results of the model without a constant term and linear trend usually show that the null hypothesis testing the existence of a unit root is not rejected. However, these results change when a constant term is added to the first model. For the same type of average correlations, all results of the model with a constant term show that the unit root hypothesis is rejected and rejecting the null hypothesis means that time series is stationary around a constant term.

The regional results, except for the model without a constant term and linear trend for idiosyncratic correlations, are identical to the other results. The null hypothesis stating that there is a unit root is rejected for idiosyncratic correlations from the regional asset-pricing model with six factors. Since the regional asset-pricing model with six factors is only conducted for the sample of local industry indexes, the results of the model are not available for other index data of each sample.

When a time series is stationary, it tends to return to the mean. Fluctuations around this mean have a broadly constant amplitude. Therefore, the time series does not rise or decrease on average in the long run. Thus, the results have some inferences for investors and portfolio managers and imply no need for more indexes for a better efficient international diversification based on local industry indexes. In other words, an efficient international diversification can be provided with the same number of indexes as before. On the other hand, average correlations of local industry indexes are generally expected to rise over time because local countries and local industries might have been more integrated year by year due to the globalization. However, it is found that there is no substantial increase in time series fluctuation of average correlations through time. Moreover, average correlations of local industry indexes move upward or downward around a constant value without an increasing or decreasing trend. Therefore, there are risk reduction benefits according to Markowitz's MPT stating that risk reduction is based on correlations. Risk reduction has greater benefits if security returns are negatively correlated. As the value of average correlations does not rise through time, there is not a decrease in risk reduction benefits. The investment risk can be eliminated by international diversification based on local industry indexes. In other words, international diversification based on local industry indexes can still be beneficial for investors and portfolio managers. The results of indexes in other summary sections are almost identical to the results in this section.

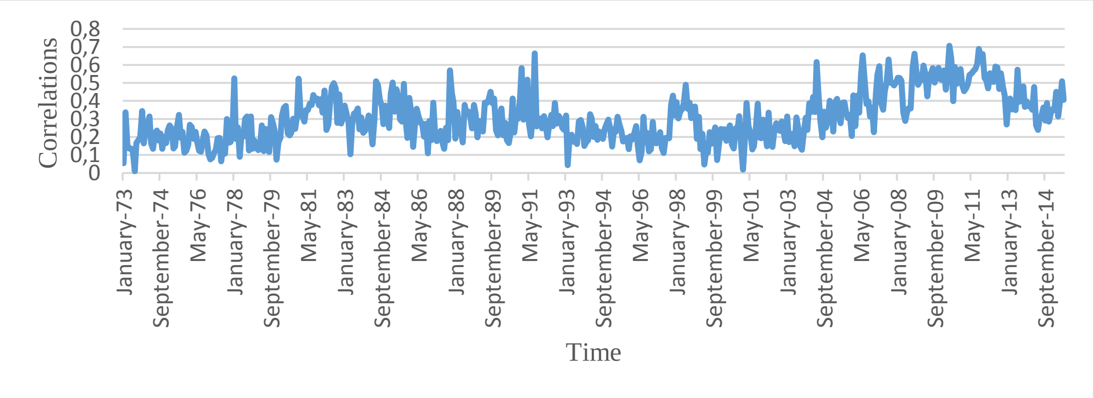

Figure 3.2. Average Correlations against Global Market Return for Local Industry Indexes

Table 3.6. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for Correlations of Local Industry Indexes against Global Market Return

Variable	Coefficient	t-Statistic	Prob.
AGAINST_GLOBAL(-1)	-0.009691	-0.790873	0.429400
D(AGAINST_GLOBAL(-1))	-0.562555	-12.43867	0.000000
D(AGAINST_GLOBAL(-2))	-0.450688	-8.845751	0.000000
D(AGAINST_GLOBAL(-3))	-0.366273	-7.037988	0.000000
D(AGAINST_GLOBAL(-4))	-0.189859	-3.766215	0.000200
D(AGAINST_GLOBAL(-5))	-0.169907	-3.861862	0.000100
The ADF Test Statistic		-0.790873	0.37320

Table 3.7. Unit Root Test Statistics based on the Model with a Constant Term for Correlations of Local Industry Indexes against Global Market Return

Variable	Coefficient	t-Statistic	Prob.
AGAINST_GLOBAL(-1)	-0.115949	-3.315358	0.0010
D(AGAINST_GLOBAL(-1))	-0.479672	-9.297363	0.0000
D(AGAINST_GLOBAL(-2))	-0.383008	-7.011670	0.0000
D(AGAINST_GLOBAL(-3))	-0.314538	-5.827954	0.0000
D(AGAINST_GLOBAL(-4))	-0.153367	-2.995865	0.0029
D(AGAINST_GLOBAL(-5))	-0.148602	-3.371444	0.0008
The ADF Test Statistic		-3.315358	0.014700

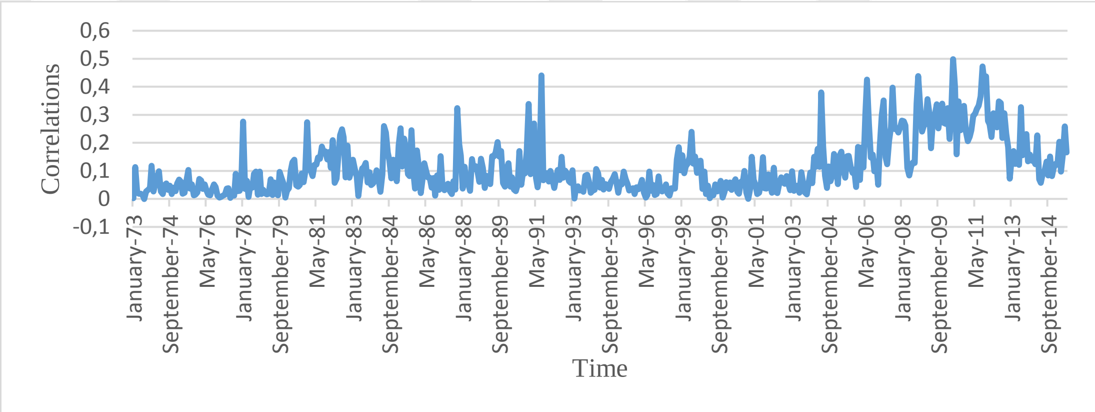

Figure 3.3. Single-Factor Model Implied Correlations for Local Industry Indexes

Table 3.8. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for Single-Factor Model Implied Correlations of Local Industry Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IMPLIED(-1)	-0.030279	-1.4819520	0.1390
D(MEAN_IMPLIED(-1))	-0.529676	-11.1425600	0.0000
D(MEAN_IMPLIED(-2))	-0.446334	-8.6066490	0.0000
D(MEAN_IMPLIED(-3))	-0.361045	-6.6276180	0.0000
D(MEAN_IMPLIED(-4))	-0.212422	-3.9395450	0.0001
D(MEAN_IMPLIED(-5))	-0.224633	-4.4591480	0.0000
D(MEAN_IMPLIED(-6))	-0.125290	-2.8031550	0.0053
The ADF Test Statistic		-1.481952	0.1295

Table 3.9. Unit Root Test Statistics based on the Model with a Constant Term for Single-Factor Model Implied Correlations of Local Industry Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IMPLIED(-1)	-0.143027	-4.216815	0.0000
D(MEAN_IMPLIED(-1))	-0.399405	-8.146469	0.0000
D(MEAN_IMPLIED(-2))	-0.298119	-6.159782	0.0000
D(MEAN_IMPLIED(-3))	-0.185253	-4.221069	0.0000
The ADF Test Statistic		-4.216815	0.0007

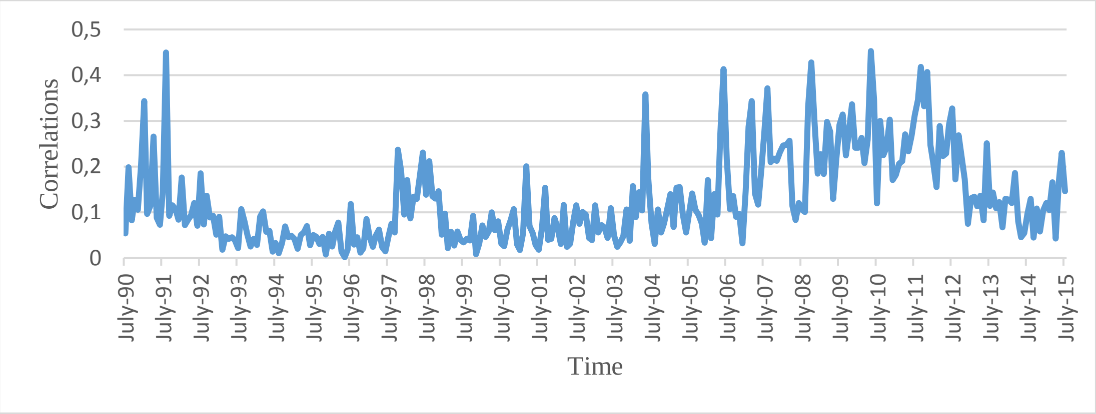

Figure 3.4. Average FF3F Model Implied Correlations for Local Industry Indexes

Table 3.10. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for FF3F Model Implied Correlations of Local Industry Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IMPLIED(-1)	-0.041824	-1.562923	0.1192
D(MEAN_IMPLIED(-1))	-0.493249	-8.016222	0.0000
D(MEAN_IMPLIED(-2))	-0.414376	-6.357808	0.0000
D(MEAN_IMPLIED(-3))	-0.285775	-4.437052	0.0000
D(MEAN_IMPLIED(-4))	-0.117592	-2.015445	0.0448
The ADF Test Statistic		-1.562923	0.1109

Table 3.11. Unit Root Test Statistics based on the Model with a Constant Term for FF3F Model Implied Correlations of Local Industry Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IMPLIED(-1)	-0.170886	-3.491794	0.0006
D(MEAN_IMPLIED(-1))	-0.374101	-5.703762	0.0000
D(MEAN_IMPLIED(-2))	-0.304676	-4.795576	0.0000
D(MEAN_IMPLIED(-3))	-0.189786	-3.302192	0.0011
The ADF Test Statistic		-3.491794	0.0089

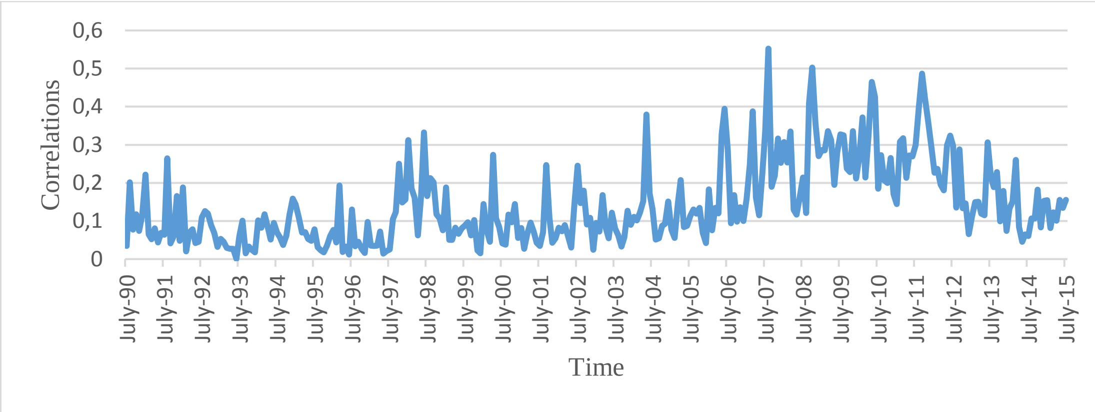

Figure 3.5. Average Regional Asset-Pricing Model Implied Correlations for Local Industry Indexes from the Asia-Pacific Region

Table 3.12. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for Regional Asset-Pricing Model Implied Correlations of Local Industry Indexes from the Asia-Pacific Region

Variable	Coefficient	t-Statistic	Prob.
IMPLIED_ASIA(-1)	-0.042470	-1.605572	0.1095
D(IMPLIED_ASIA(-1))	-0.457867	-7.525669	0.0000
D(IMPLIED_ASIA(-2))	-0.371534	-5.803434	0.0000
D(IMPLIED_ASIA(-3))	-0.259986	-4.122557	0.0000
D(IMPLIED_ASIA(-4))	-0.158740	-2.761890	0.0061
The ADF Test Statistic		-1.605572	0.1021

Table 3.13. Unit Root Test Statistics based on the Model with a Constant Term for Regional Asset-Pricing Model Implied Correlations of Local Industry Indexes from the Asia-Pacific Region

Variable	Coefficient	t-Statistic	Prob.
IMPLIED_ASIA(-1)	-0.188902	-3.813068	0.0002
D(IMPLIED_ASIA(-1))	-0.324038	-4.928411	0.0000
D(IMPLIED_ASIA(-2))	-0.243502	-3.828452	0.0002
D(IMPLIED_ASIA(-3))	-0.144767	-2.519071	0.0123
The ADF Test Statistic		-3.813068	0.0031

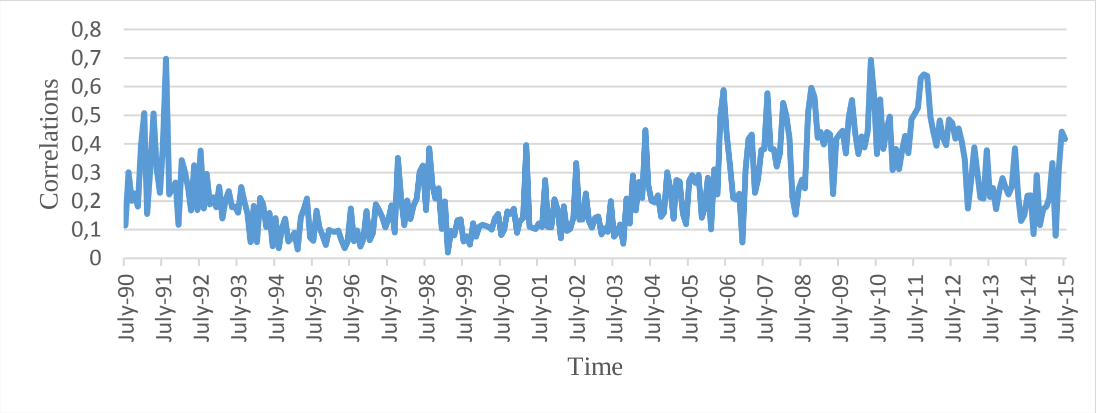

Figure 3.6. Average Regional Asset-Pricing Model Implied Correlations for Local Industry Indexes from the European Region

Table 3.14. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for Regional Asset-Pricing Model Implied Correlations of Local Industry Indexes from the European Region

Variable	Coefficient	t-Statistic	Prob.
IMPLIED_EUROPE(-1)	-0.022532	-1.082076	0.2801
D(IMPLIED_EUROPE(-1))	-0.548975	-9.066859	0.0000
D(IMPLIED_EUROPE(-2))	-0.396221	-5.891858	0.0000
D(IMPLIED_EUROPE(-3))	-0.231452	-3.443561	0.0007
D(IMPLIED_EUROPE(-4))	-0.093400	-1.577135	0.1159
The ADF Test Statistic		-1.082076	0.2526

Table 3.15. Unit Root Test Statistics based on the Model with a Constant Term for Regional Asset-Pricing Model Implied Correlations of Local Industry Indexes from the European Region

Variable	Coefficient	t-Statistic	Prob.
IMPLIED_EUROPE(-1)	-0.159443	-3.664875	0.0003
D(IMPLIED_EUROPE(-1))	-0.393929	-6.396463	0.0000
D(IMPLIED_EUROPE(-2))	-0.219220	-3.855196	0.0001
The ADF Test Statistic		-3.664875	0.0051

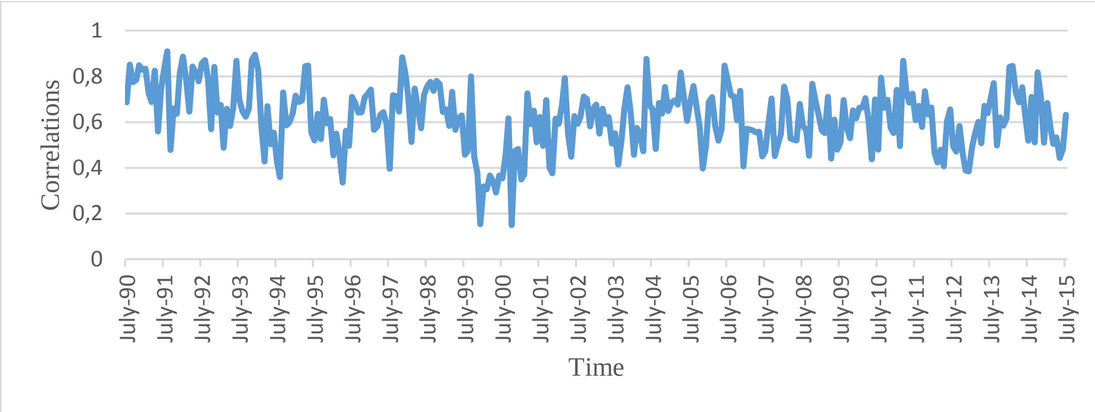

Figure 3.7. Average Regional Asset-Pricing Model Implied Correlations for Local Industry Indexes from the Japanese Region

Table 3.16. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for Regional Asset-Pricing Model Implied Correlations of Local Industry Indexes from the Japanese Region

Variable	Coefficient	t-Statistic	Prob.
IMPLIED_JAPAN(-1)	-0.011282	-0.997494	0.3194
D(IMPLIED_JAPAN(-1))	-0.602345	-10.393390	0.0000
D(IMPLIED_JAPAN(-2))	-0.413839	-6.358829	0.0000
D(IMPLIED_JAPAN(-3))	-0.326812	-5.028559	0.0000
D(IMPLIED_JAPAN(-4))	-0.197052	-3.433736	0.0007
The ADF Test Statistic		-0.997494	0.2855

Table 3.17. Unit Root Test Statistics based on the Model with a Constant Term for Regional Asset-Pricing Model Implied Correlations of Local Industry Indexes from the Japanese Region

Variable	Coefficient	t-Statistic	Prob.
IMPLIED_JAPAN(-1)	-0.440176	-7.436958	0.0000
D(IMPLIED_JAPAN(-1))	-0.195794	-3.444747	0.0007
The ADF Test Statistic		-7.436958	0.0000

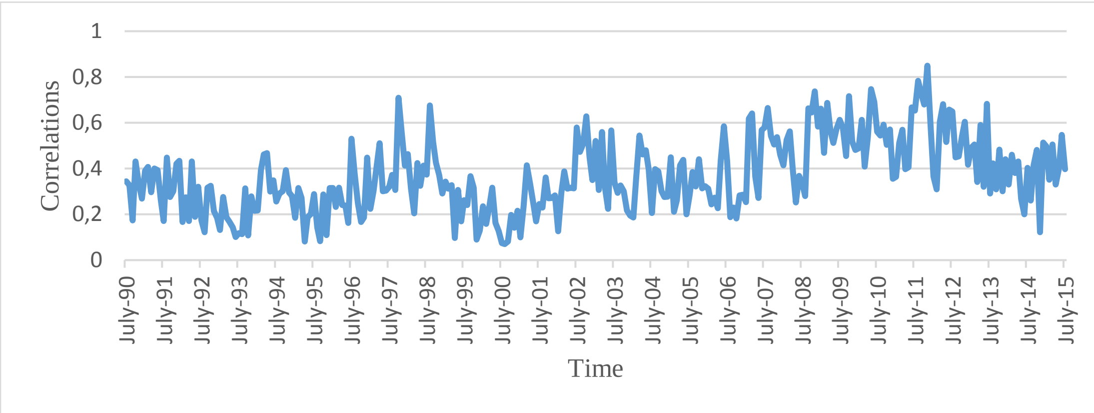

Figure 3.8. Average Regional Asset-Pricing Model Implied Correlations for Local Industry Indexes from the North American Region

Table 3.18. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for Regional Asset-Pricing Model Implied Correlations of Local Industry Indexes from the North American Region

Variable	Coefficient	t-Statistic	Prob.
IMPLIED_NORTH(-1)	-0.021694	-1.179508	0.2392
D(IMPLIED_NORTH(-1))	-0.552433	-9.410897	0.0000
D(IMPLIED_NORTH(-2))	-0.356731	-5.643035	0.0000
D(IMPLIED_NORTH(-3))	-0.183954	-3.207740	0.0015
The ADF Test Statistic		-1.179508	0.2176

Table 3.19. Unit Root Test Statistics based on the Model with a Constant Term for Regional Asset-Pricing Model Implied Correlations of Local Industry Indexes from the North American Region

Variable	Coefficient	t-Statistic	Prob.
IMPLIED_NORTH(-1)	-0.241505	-4.622355	0.0000
D(IMPLIED_NORTH(-1))	-0.366557	-5.744320	0.0000
D(IMPLIED_NORTH(-2))	-0.185614	-3.239654	0.0013
The ADF Test Statistic		-4.622355	0.0001

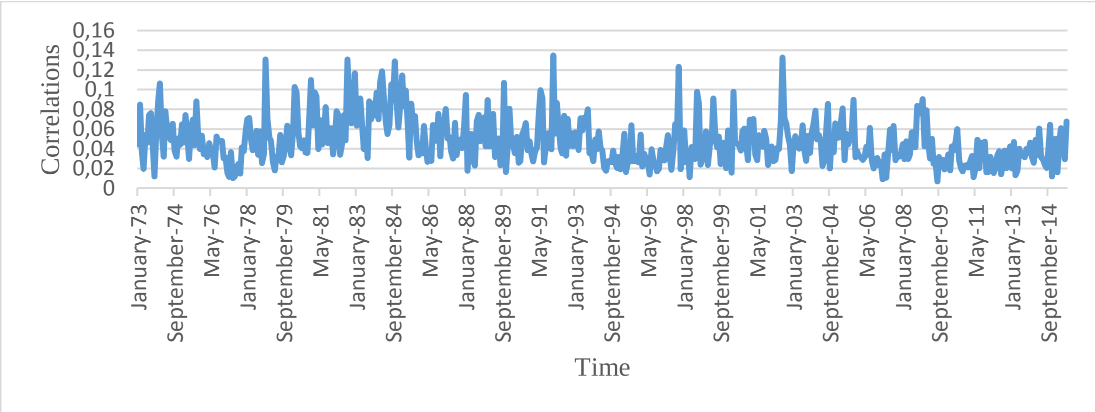

Figure 3.9. Average Idiosyncratic Correlations from a Single-Factor Model for Local Industry Indexes

Table 3.20. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for Idiosyncratic Correlations from a Single-Factor Model for Local Industry Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IDIO(-1)	-0.029193	-1.553669	0.1209
D(MEAN_IDIO(-1))	-0.637309	-13.81617	0.0000
D(MEAN_IDIO(-2))	-0.482888	-9.218946	0.0000
D(MEAN_IDIO(-3))	-0.297729	-5.443182	0.0000
D(MEAN_IDIO(-4))	-0.281507	-5.492361	0.0000
D(MEAN_IDIO(-5))	-0.213434	-4.886476	0.0000
The ADF Test Statistic		-1.553669	0.1130

Table 3.21. Unit Root Test Statistics based on the Model with a Constant Term for Idiosyncratic Correlations from a Single-Factor Model for Local Industry Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IDIO(-1)	-0.407140	-7.784313	0.0000
D(MEAN_IDIO(-1))	-0.301813	-5.781814	0.0000
D(MEAN_IDIO(-2))	-0.188084	-4.308815	0.0000
The ADF Test Statistic		-7.784313	0.0000

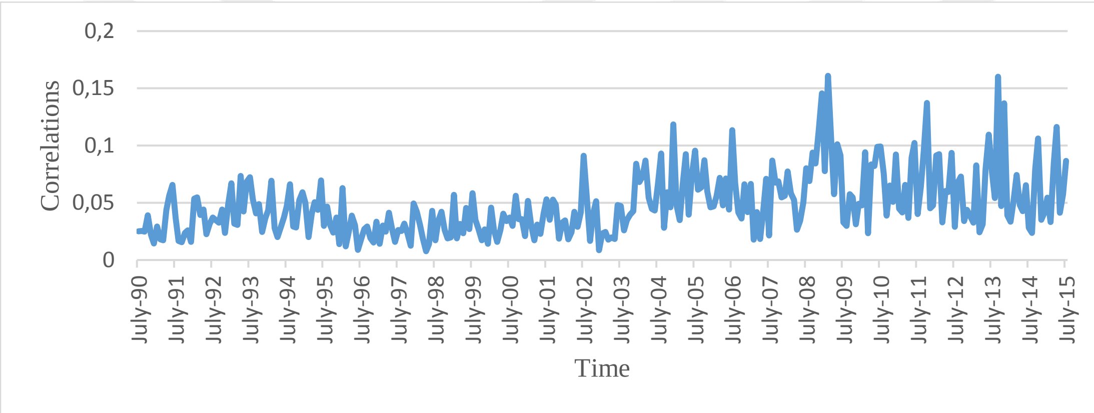

Figure 3.10. Average Idiosyncratic Correlations from the FF3F Model for Local Industry Indexes

Table 3.22. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for Idiosyncratic Correlations from the FF3F Model for Local Industry Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IDIO(-1)	-0.033497	-1.264008	0.2072
D(MEAN_IDIO(-1))	-0.719964	-12.072150	0.0000
D(MEAN_IDIO(-2))	-0.533703	-8.215763	0.0000
D(MEAN_IDIO(-3))	-0.266977	-4.669569	0.0000
The ADF Test Statistic		-1.264008	0.1898

Table 3.23. Unit Root Test Statistics based on the Model with a Constant Term for Idiosyncratic Correlations from the FF3F Model for Local Industry Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IDIO(-1)	-0.272051	-4.017181	0.0001
D(MEAN_IDIO(-1))	-0.541845	-7.252169	0.0000
D(MEAN_IDIO(-2))	-0.415630	-5.882219	0.0000
D(MEAN_IDIO(-3))	-0.207829	-3.582627	0.0004
The ADF Test Statistic		-4.017181	0.0015

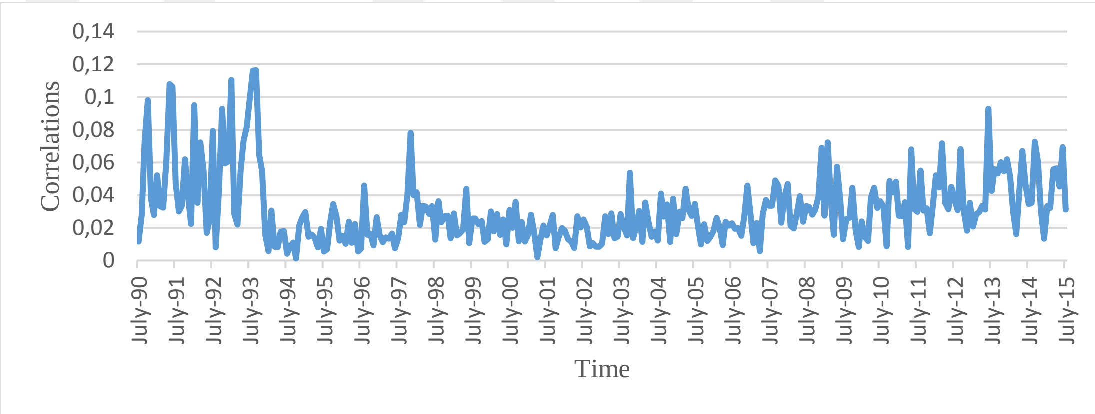

Figure 3.11. Average Idiosyncratic Correlations from the Regional Asset-Pricing Model for Local Industry Indexes from the Asia-Pacific Region

Table 3.24. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for Idiosyncratic Correlations from the Regional Asset-Pricing Model for Local Industry Indexes from the Asia-Pacific Region

Variable	Coefficient	t-Statistic	Prob.
IDIO_ASIA(-1)	-0.074746	-2.512332	0.0125
D(IDIO_ASIA(-1))	-0.447962	-7.786467	0.0000
D(IDIO_ASIA(-2))	-0.290852	-5.253427	0.0000
The ADF Test Statistic		-2.512332	0.0118

Table 3.25. Unit Root Test Statistics based on the Model with a Constant Term for Idiosyncratic Correlations from the Regional Asset-Pricing Model for Local Industry Indexes from the Asia-Pacific Region

Variable	Coefficient	t-Statistic	Prob.
IDIO_ASIA(-1)	-0.320841	-5.354656	0.0000
D(IDIO_ASIA(-1))	-0.291516	-4.494151	0.0000
D(IDIO_ASIA(-2))	-0.201563	-3.548736	0.0005
The ADF Test Statistic		-5.354656	0.0000

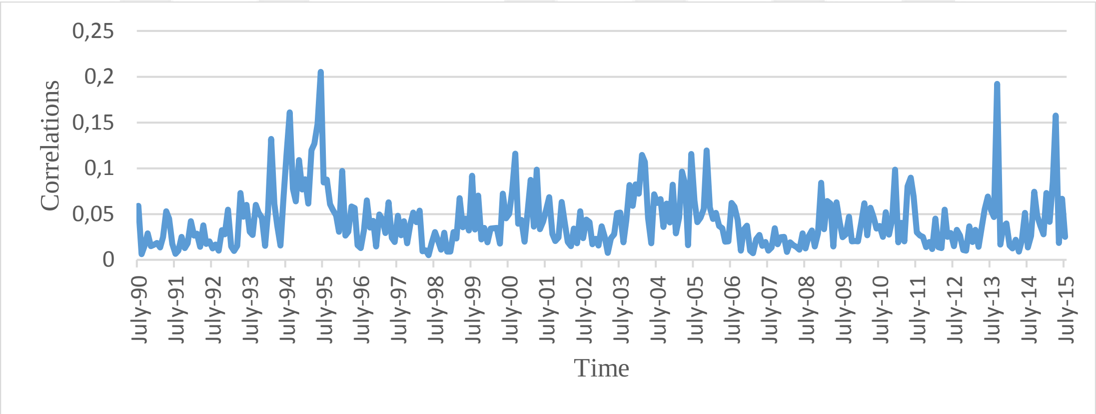

Figure 3.12. Average Idiosyncratic Correlations from the Regional Asset-Pricing Model for Local Industry Indexes from the European Region

Table 3.26. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for Idiosyncratic Correlations from the Regional Asset-Pricing Model for Local Industry Indexes from the European Region

Variable	Coefficient	t-Statistic	Prob.
IDIO_EUROPE(-1)	-0.058711	-1.708659	0.0886
D(IDIO_EUROPE(-1))	-0.623535	-9.763390	0.0000
D(IDIO_EUROPE(-2))	-0.449498	-6.398309	0.0000
D(IDIO_EUROPE(-3))	-0.323401	-4.626416	0.0000
D(IDIO_EUROPE(-4))	-0.180263	-3.017280	0.0028
The ADF Test Statistic		-1.708659	0.0829

Table 3.27. Unit Root Test Statistics based on the Model with a Constant Term for Idiosyncratic Correlations from the Regional Asset Pricing Model for Local Industry Indexes from the European Region

Variable	Coefficient	t-Statistic	Prob.
IDIO_EUROPE(-1)	-0.468963	-7.607904	0.0000
D(IDIO_EUROPE(-1))	-0.202984	-3.572906	0.0004
The ADF Test Statistic		-7.607904	0.0000

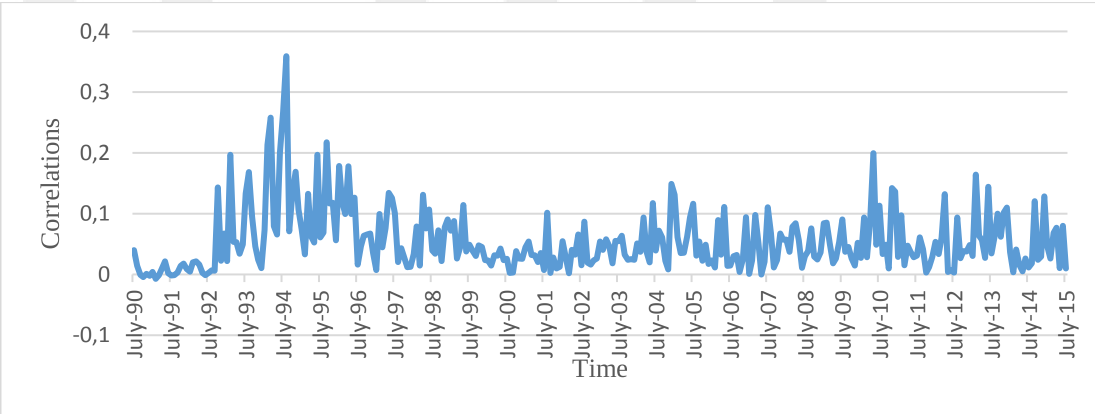

Figure 3.13. Average Idiosyncratic Correlations from the Regional Asset-Pricing Model for Local Industry Indexes from the Japanese Region

Table 3.28. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for Idiosyncratic Correlations from the Regional Asset-Pricing Model for Local Industry Indexes from the Japanese Region

Variable	Coefficient	t-Statistic	Prob.
IDIO_JAPAN(-1)	-0.085506	-2.066646	0.0397
D(IDIO_JAPAN(-1))	-0.622651	-9.456510	0.0000
D(IDIO_JAPAN(-2))	-0.507524	-7.280543	0.0000
D(IDIO_JAPAN(-3))	-0.393231	-5.841405	0.0000
D(IDIO_JAPAN(-4))	-0.194176	-3.357309	0.0009
The ADF Test Statistic		-2.066646	0.0374

Table 3.29. Unit Root Test Statistics based on the Model with a Constant Term for Idiosyncratic Correlations from the Regional Asset Pricing Model for Local Industry Indexes from the Japanese Region

Variable	Coefficient	t-Statistic	Prob.
IDIO_JAPAN(-1)	-0.322828	-4.210426	0.0000
D(IDIO_JAPAN(-1))	-0.437124	-5.321041	0.0000
D(IDIO_JAPAN(-2))	-0.368101	-4.703576	0.0000
D(IDIO_JAPAN(-3))	-0.299742	-4.236696	0.0000
D(IDIO_JAPAN(-4))	-0.145526	-2.500331	0.0130
The ADF Test Statistic		-4.210426	0.0008

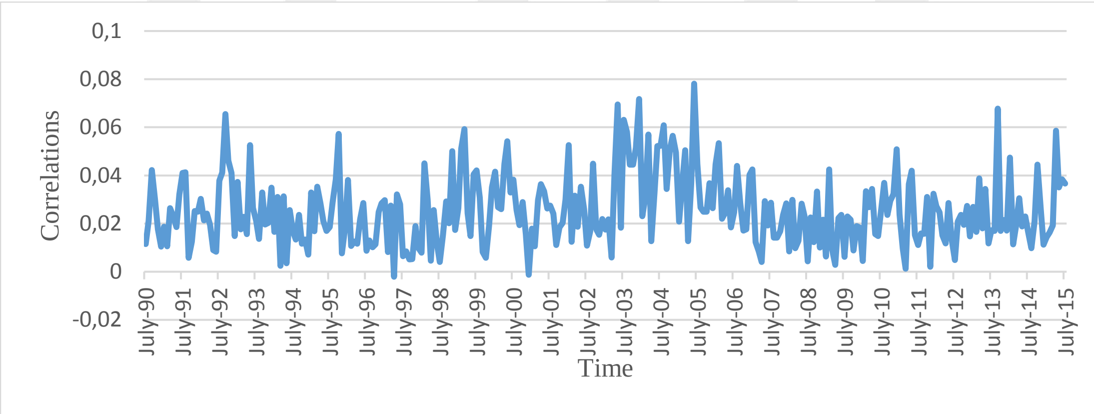

Figure 3.14. Average Idiosyncratic Correlations from the Regional Asset-Pricing Model for Local Industry Indexes from the North American Region

Table 3.30. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for Idiosyncratic Correlations from the Regional Asset-Pricing Model for Local Industry Indexes from the North American Region

Variable	Coefficient	t-Statistic	Prob.
IDIO_NORTH(-1)	-0.054939	-1.742972	0.0824
D(IDIO_NORTH(-1))	-0.624612	-10.405440	0.0000
D(IDIO_NORTH(-2))	-0.480982	-7.695007	0.0000
D(IDIO_NORTH(-3))	-0.296648	-5.306393	0.0000
The ADF Test Statistic		-1.742972	0.0772

Table 3.31. Unit Root Test Statistics based on the Model with a Constant Term for Idiosyncratic Correlations from the Regional Asset-Pricing Model for Local Industry Indexes from the North American Region

Variable	Coefficient	t-Statistic	Prob.
IDIO_NORTH(-1)	-0.747646	-13.345030	0.0000
The ADF Test Statistic		-13.345030	0.0000

3.4.1.2. Results for Local Country Indexes

Figure 3.15 shows average pair-wise correlations for local country indexes from all countries for the full sample. Like Figure 3.1, the average correlations at some points deviate from the long-run average correlations. The spikes that are associated with crisis periods in Figure 3.1 are almost seen in the same time intervals in Figure 3.15. Thus, increases in time series of average correlations for local country indexes coincide with the crisis periods. Although average correlations are generally expected to rise through time due to the globalization, average correlations of local country indexes do not indicate a positive trend in Figure 3.15.

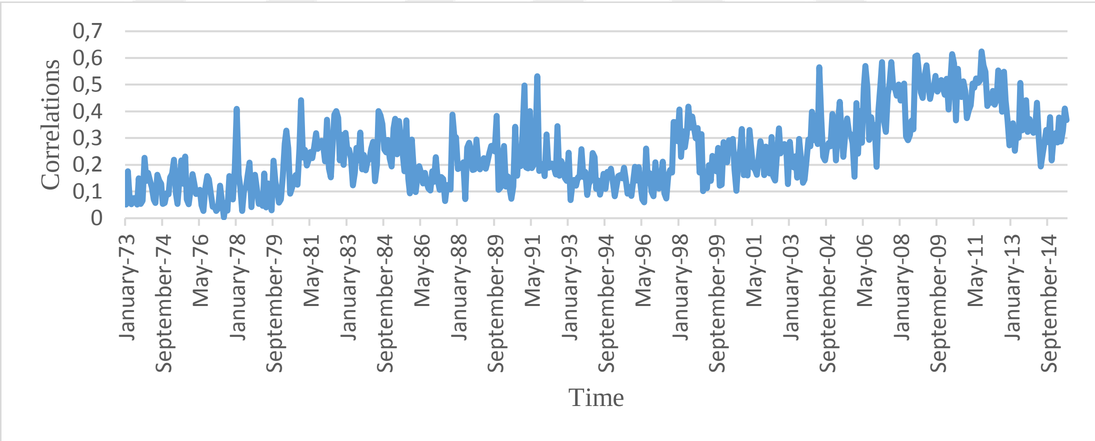

Figure 3.15. Average Pair-wise Correlations for Local Country Indexes

When the results of Figure 3.1 and Figure 3.15 are compared, the highest point for average correlations of local country indexes is greater than the highest point for those of local industry indexes according to visual inspection. In other words, average correlations of local industries are generally lower than average correlations of local countries. Average correlations fluctuate through time and appear to revert during periods without crisis, according to the time series of local country indexes in figures.

The findings are expanded with the test statistics attained as a result of Equation (3.23) and Equation (3.24). Table 3.32 indicates unit root test statistics based on the model without a constant term and linear trend for pair-wise correlations of local country indexes for the full sample. *RD_NAT* is the average correlation variable of local country indexes. The unit root hypothesis is not rejected at any significance level and there is a unit root based on the results in Table 3.32. Table 3.33 presents unit root test statistics based on the model with a constant term for pair-wise correlations of local country indexes for the full sample. The existence of the unit root hypothesis is rejected at the significance level of 10% according to findings. The time series is stationary. When the results of Table 3.5 and Table 3.33 are compared, it can be clearly said that both time series of average correlations are stationary for the model with a constant term. However, the significance level of local industry indexes is lower. The findings of local industry indexes are more reliable than those of local country indexes for investors and portfolio managers.

The results from Table 3.34 to Table 3.43, and Figure 3.16 to Figure 3.20 include the findings of additional average correlations for the sample of local country indexes. The results of every average correlation are almost identical to the results of average pair-wise correlations for local country indexes of the full sample. Results of the model without a constant term and linear trend indicate that the null hypothesis indicating that there is a unit root is not rejected regardless of the correlation measures. Thus, the time series is not stationary. However, the results of local country indexes change completely like those of local industry indexes when the model with a constant term is used. According to the results of the model with a constant term, the null hypothesis stating that there is a unit root is rejected and shows that the average correlation series is stationary through time.

If international markets have been a higher correlation with the effect of globalization, time series of average correlations have a positive trend and the benefits of international diversification could steadily decrease. However, according to the results of local country indexes, there is not an increasing trend for average correlations through time. Therefore, international diversification across local country indexes can help to reduce investment risk and still has benefits for investors and portfolio managers.

Table 3.32. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for Pair-wise Correlations of Local Country Indexes

Variable	Coefficient	t-Statistic	Prob.
RD_NAT(-1)	-0.008531	-0.652949	0.5141
D(RD_NAT(-1))	-0.604057	-13.14145	0.0000
D(RD_NAT(-2))	-0.500766	-9.570881	0.0000
D(RD_NAT(-3))	-0.411233	-7.413777	0.0000
D(RD_NAT(-4))	-0.272150	-4.929336	0.0000
D(RD_NAT(-5))	-0.218818	-4.240460	0.0000
D(RD_NAT(-6))	-0.115340	-2.584373	0.0100
The ADF Test Statistic		-0.652949	0.4341

Table 3.33. Unit Root Test Statistics based on the Model with a Constant Term for Pair-wise Correlations of Local Country Indexes

Variable	Coefficient	t-Statistic	Prob.
RD_NAT(-1)	-0.084891	-2.819374	0.0050
D(RD_NAT(-1))	-0.526836	-10.54615	0.0000
D(RD_NAT(-2))	-0.427495	-7.927012	0.0000
D(RD_NAT(-3))	-0.331613	-6.119776	0.0000
D(RD_NAT(-4))	-0.190915	-3.716761	0.0002
D(RD_NAT(-5))	-0.136355	-3.075157	0.0022
The ADF Test Statistic		-2.819374	0.0562

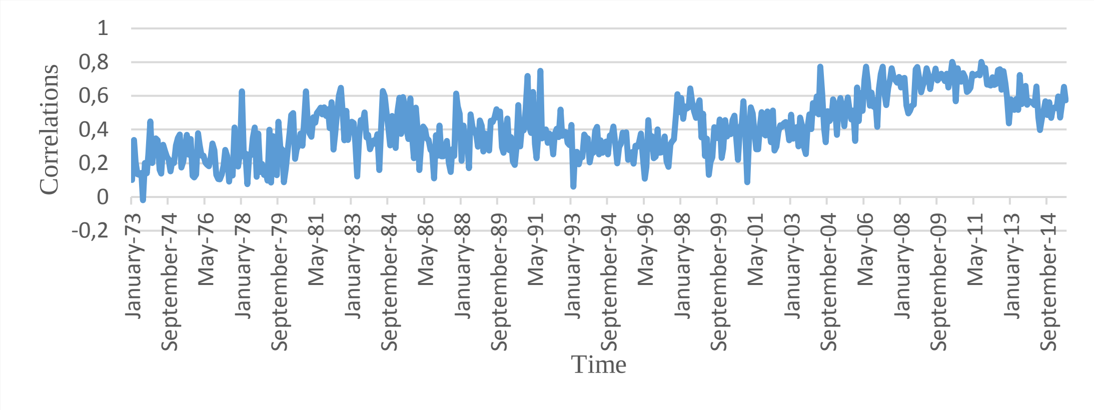

Figure 3.16. Average Correlations against Global Market Return for Local Country Indexes

Table 3.34. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for Correlations of Local Country Indexes against Global Market Return

Variable	Coefficient	t-Statistic	Prob.
AGAINST_GLOBAL(-1)	-0.005239	-0.488442	0.6255
D(AGAINST_GLOBAL(-1))	-0.601707	-13.38961	0.0000
D(AGAINST_GLOBAL(-2))	-0.493243	-9.649645	0.0000
D(AGAINST_GLOBAL(-3))	-0.415023	-7.942885	0.0000
D(AGAINST_GLOBAL(-4))	-0.243950	-4.817255	0.0000
D(AGAINST_GLOBAL(-5))	-0.184479	-4.195327	0.0000
The ADF Test Statistic		-0.488442	0.5042

Table 3.35. Unit Root Test Statistics based on the Model with a Constant Term for Correlations of Local Country Indexes against Global Market Return

Variable	Coefficient	t-Statistic	Prob.
AGAINST_GLOBAL(-1)	-0.091251	-2.884102	0.0041
D(AGAINST_GLOBAL(-1))	-0.534358	-10.61431	0.0000
D(AGAINST_GLOBAL(-2))	-0.438946	-8.111078	0.0000
D(AGAINST_GLOBAL(-3))	-0.373961	-6.952785	0.0000
D(AGAINST_GLOBAL(-4))	-0.215688	-4.211245	0.0000
D(AGAINST_GLOBAL(-5))	-0.168658	-3.833526	0.0001
The ADF Test Statistic		-2.884102	0.0479

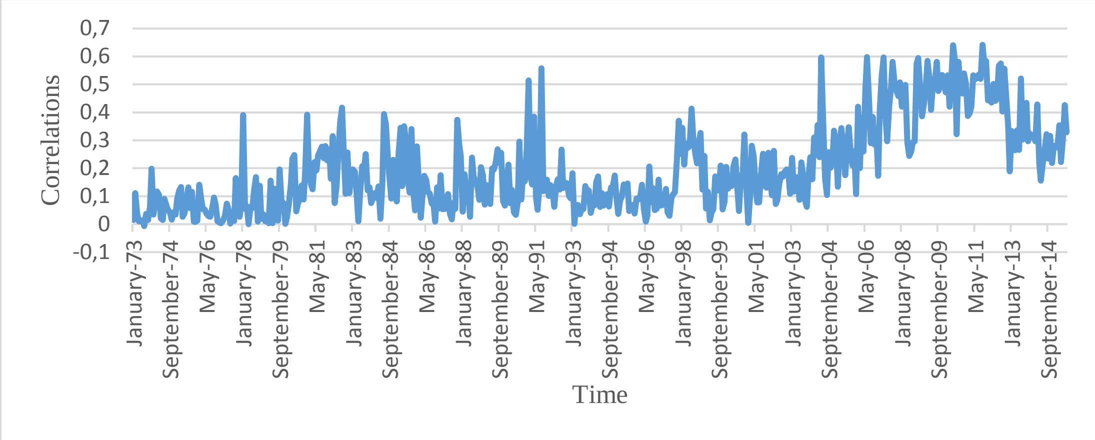

Figure 3.17. Single-Factor Model Implied Correlations for Local Country Indexes

Table 3.36. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for Single-Factor Model Implied Correlations of Local Country Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IMPLIED(-1)	-0.018856	-1.147384	0.2518
D(MEAN_IMPLIED(-1))	-0.563386	-12.224660	0.0000
D(MEAN_IMPLIED(-2))	-0.477805	-9.242440	0.0000
D(MEAN_IMPLIED(-3))	-0.378501	-7.152365	0.0000
D(MEAN_IMPLIED(-4))	-0.185556	-3.650266	0.0003
D(MEAN_IMPLIED(-5))	-0.168483	-3.800722	0.0002
The ADF Test Statistic		-1.147384	0.2291

Table 3.37. Unit Root Test Statistics based on the Model with a Constant Term for Single-Factor Model Implied Correlations of Local Country Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IMPLIED(-1)	-0.078082	-2.683888	0.0075
D(MEAN_IMPLIED(-1))	-0.517627	-10.461360	0.0000
D(MEAN_IMPLIED(-2))	-0.440661	-8.220529	0.0000
D(MEAN_IMPLIED(-3))	-0.350638	-6.510580	0.0000
D(MEAN_IMPLIED(-4))	-0.166569	-3.255657	0.0012
D(MEAN_IMPLIED(-5))	-0.157269	-3.546796	0.0004
The ADF Test Statistic		-2.683888	0.0775

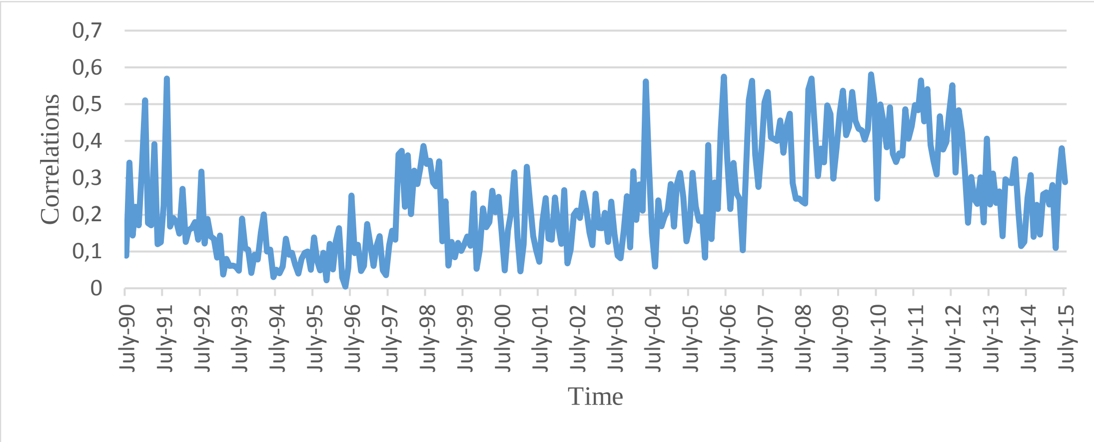

Figure 3.18. Average FF3F Model Implied Correlations for Local Country Indexes

Table 3.38. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for FF3F Model Implied Correlations of Local Country Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IMPLIED(-1)	-0.021212	-1.028067	0.3048
D(MEAN_IMPLIED(-1))	-0.585369	-9.722806	0.0000
D(MEAN_IMPLIED(-2))	-0.470605	-7.203405	0.0000
D(MEAN_IMPLIED(-3))	-0.371831	-5.716483	0.0000
D(MEAN_IMPLIED(-4))	-0.139717	-2.408452	0.0166
The ADF Test Statistic		-1.028067	0.2734

Table 3.39. Unit Root Test Statistics based on the Model with a Constant Term for FF3F Model Implied Correlations of Local Country Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IMPLIED(-1)	-0.119311	-2.603495	0.0097
D(MEAN_IMPLIED(-1))	-0.509147	-7.521842	0.0000
D(MEAN_IMPLIED(-2))	-0.412969	-5.972985	0.0000
D(MEAN_IMPLIED(-3))	-0.331727	-4.976006	0.0000
D(MEAN_IMPLIED(-4))	-0.118779	-2.040627	0.0422
The ADF Test Statistic		-2.603495	0.0934

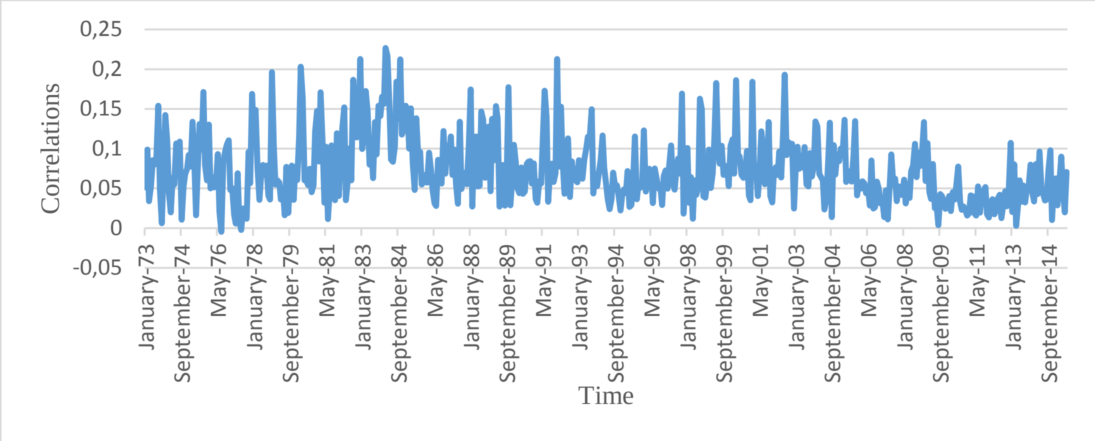

Figure 3.19. Average Idiosyncratic Correlations from a Single-Factor Model for Local Country Indexes

Table 3.40. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for Idiosyncratic Correlations from a Single-Factor Model for Local Country Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IDIO(-1)	-0.034622	-1.589492	0.1126
D(MEAN_IDIO(-1))	-0.672881	-14.04209	0.0000
D(MEAN_IDIO(-2))	-0.582552	-10.43152	0.0000
D(MEAN_IDIO(-3))	-0.391657	-6.635879	0.0000
D(MEAN_IDIO(-4))	-0.375538	-6.391440	0.0000
D(MEAN_IDIO(-5))	-0.362832	-6.240422	0.0000
D(MEAN_IDIO(-6))	-0.179223	-3.327018	0.0009
D(MEAN_IDIO(-7))	-0.131856	-2.972029	0.0031
The ADF Test Statistic		-1.589492	0.1054

Table 3.41. Unit Root Test Statistics based on the Model with a Constant Term for Idiosyncratic Correlations from a Single-Factor Model for Local Country Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IDIO(-1)	-0.428494	-7.952585	0.0000
D(MEAN_IDIO(-1))	-0.289146	-5.497094	0.0000
D(MEAN_IDIO(-2))	-0.201448	-4.619160	0.0000
The ADF Test Statistic		-7.952585	0.0000

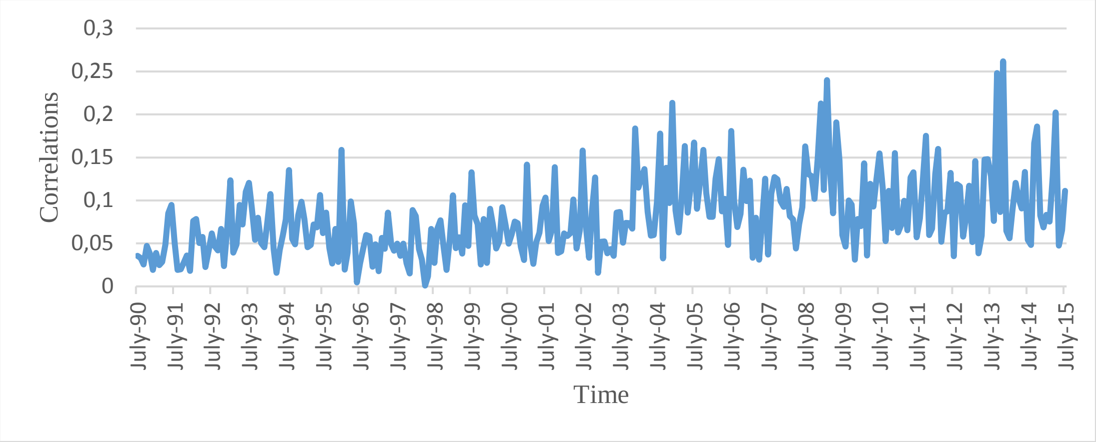

Figure 3.20. Average Idiosyncratic Correlations from the FF3F Model for Local Country Indexes

Table 3.42. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for Idiosyncratic Correlations from the FF3F Model for Local Country Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IDIO(-1)	-0.022575	-0.803983	0.4221
D(MEAN_IDIO(-1))	-0.857806	-13.621300	0.0000
D(MEAN_IDIO(-2))	-0.764524	-9.753765	0.0000
D(MEAN_IDIO(-3))	-0.588718	-7.063344	0.0000
D(MEAN_IDIO(-4))	-0.302265	-3.907302	0.0001
D(MEAN_IDIO(-5))	-0.156066	-2.634151	0.0089
The ADF Test Statistic		-0.803983	0.3671

Table 3.43. Unit Root Test Statistics based on the Model with a Constant Term for Idiosyncratic Correlations from the FF3F Model for Local Country Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IDIO(-1)	-0.367280	-4.636655	0.0000
D(MEAN_IDIO(-1))	-0.514979	-6.474294	0.0000
D(MEAN_IDIO(-2))	-0.419958	-5.809808	0.0000
D(MEAN_IDIO(-3))	-0.263368	-4.600372	0.0000
The ADF Test Statistic		-4.636655	0.0001

3.4.1.3. Mean Difference Results for Local Industry and Local Country Indexes

After average correlations of local industry and local country indexes have been calculated and their time-series evolution has been investigated, mean differences between correlations of two sets of indexes are analysed in this subsection. Table 3.44 demonstrates the mean difference test statistics for pair-wise correlations between local industry and local country indexes. According to the findings, the null hypothesis of mean difference is rejected at the significance level of 1%. The mean correlation of local industry indexes is statistically lower than the mean correlation of local country indexes.

Other tables from Table 3.45 to 3.49 provide the mean difference test statistics for other correlation measures. Regardless of the type of correlation measures, the average correlations of local industry indexes are lower than those of local country indexes. These findings show that industry diversification reduces risk more than country diversification. In other words, investing in local industry indexes rather than local country indexes has higher risk-reduction benefits. Local industry indexes provide more opportunities for efficient international diversification than local country indexes. However, the number of local industries is more than the number of local countries at the global level. This process can reduce the risk but increase transaction costs. Investors and portfolio managers should make investment decisions according to their expectations.

Table 3.44. Mean Difference Test Statistics between Pair-wise Correlations for Local Industry and Local Country Indexes

Mean Correlation of Local Industry Indexes	Mean Correlation of Local Country Indexes	Mean Difference	t-Statistic	Prob.
0.158341	0.247542	-0.089201	12.065960	0.0000

Table 3.45. Mean Difference Test Statistics between Correlations against Global Market Return for Local Industry and Local Country Indexes

Mean Correlation of Local Industry Indexes	Mean Correlation of Local Country Indexes	Mean Difference	t-Statistic	Prob.
0.306656	0.416899	-0.110243	-11.272130	0.0000

Table 3.46. Mean Difference Test Statistics between Single-Factor Model Implied Correlations for Local Industry and Local Country Indexes

Mean Correlation of Local Industry Indexes	Mean Correlation of Local Country Indexes	Mean Difference	t-Statistic	Prob.
0.112371	0.201563	-0.089192	-10.991430	0.0000

Table 3.47. Mean Difference Test Statistics between FF3F Model Implied Correlations for Local Industry and Local Country Indexes

Mean Correlation of Local Industry Indexes	Mean Correlation of Local Country Indexes	Mean Difference	t-Statistic	Prob.
0.127048	0.241119	-0.11407	-11.51938	0.0000

Table 3.48. Mean Difference Test Statistics between Idiosyncratic Correlations from a Single-Factor Model for Local Industry and Local Country Indexes

Mean Correlation of Local Industry Indexes	Mean Correlation of Local Country Indexes	Mean Difference	t-Statistic	Prob.
0.047659	0.073944	-0.026285	-12.262700	0.0000

Table 3.49. Mean Difference Test Statistics between Idiosyncratic Correlations from the FF3F Model for Local Industry and Local Country Indexes

Mean Correlation of Local Industry Indexes	Mean Correlation of Local Country Indexes	Mean Difference	t-Statistic	Prob.
0.048333	0.080768	-0.03244	-10.68029	0.0000

3.4.2. Results for Developed Countries

In this section, 23 developed countries are examined based on local industry indexes and local country indexes. For developed countries, the time-series behavior of correlation estimates is indicated from Figure A.1 to Figure A.6 for local industry indexes while the time-series behavior of local country indexes' is shown from Figure A.7 to Figure A.12 in Appendix A. The results from Table A.1 to Table A.12 indicate the findings for pair-wise correlations, correlations against global market return, single-factor model implied correlations, the FF3F model implied correlations, idiosyncratic correlations from a single-factor model and idiosyncratic correlations from the FF3F model of local industry indexes. The same correlation measures are demonstrated from Table A.13 to Table A.24 for local country indexes. The results of two models which is conducted within the same correlation are different except for three correlation measures explained in detail in the following sections. The results of the mean difference tests for local industry and local country indexes are also given from Table A.25 to Table A.30 in Appendix A.

3.4.2.1. Results for Local Industry Indexes

The findings of local industry indexes of developed countries are almost identical to those of local industry indexes of the full sample. The results of Figure A.1 through Figure A.6 display the findings of average correlations of local industry indexes for developed countries. Figure A.3 includes single-factor model implied correlations. There are some considerable deviations. However, the average correlations in this figure are closer to the zero value, unlike other figures. Average correlations of local industry indexes do not show a long-term upward trend. The time series of average correlations are mostly stationary for local industry indexes from developed markets.

Consistent results with the full sample's results are obtained from Table A.1 to Table A.12 for local industry indexes of developed countries except for Table A.7. According to each type of average correlation in tables, the null hypothesis including that there is a unit root is not rejected for the model without a constant term and linear trend except for the results of the FF3F model implied correlations. Other results of the model with a constant term allow to reject the null hypothesis stating that there is a unit root regardless of the correlation measure. The time series is stationary.

Because of the behavior of average correlations observed, it is understood that international diversification still works to reduce portfolio risk. Therefore, international diversification which is based on local industry indexes can still be beneficial for international investors.

3.4.2.2. Results for Local Country Indexes

The findings of local country indexes from developed countries are provided from Table A.13 to Table A.24, and Figure A.7 to A.12 in Appendix A. There is a distinct increase in the average correlations after 1999 in figures. The general conclusion for local country indexes of developed countries is the same as the full sample's for different average correlation measures except for the model with a constant term for pair-wise and single-factor model. The result of the first model in which the unit root hypothesis is not rejected is consistent with those of the full sample regardless of the correlation type. When a constant term is inserted into the model, the results change only for pair-wise and single-factor models. The time series of average correlations are stationary for the majority of the results.

Therefore, international diversification can be beneficial for this sample, too. Investing in local country indexes from developed countries can still provide risk reduction benefits. While average correlations are expected to increase through time as a result of globalization, they do not show a positive trend. Therefore, diversifying the portfolio across local country indexes is an effective way for international diversification.

3.4.2.3. Mean Difference Results for Local Industry and Local Country Indexes

Tables from Table A.25 to Table A.30 present the mean difference test statistics for local industry and local country indexes from developed countries in Appendix A. The findings are consistent with the findings of the full sample and show that local industry indexes have lower mean correlations than local country indexes. It can be said that local country indexes are more integrated into the global market than local industry indexes.

3.4.3. Results for Emerging Countries

In this section, 14 emerging countries are just examined based on local industry indexes and local country indexes. Average correlation estimates of emerging countries are shown from Figure B.1 to Figure B.6 for local industry indexes, and Figure B.7 to Figure B.12 for local country indexes in Appendix B. The results from Table B.1 to Table B.12 are provided for local industry indexes based on pair-wise correlations, correlations against global market return, single-factor model implied correlations, the FF3F model implied correlations, idiosyncratic correlations from a single-factor model and idiosyncratic correlations from the FF3F model. Moreover, the results of the same correlation types for local country indexes are presented from Table B.13 to Table B.24 for this sample. As can be seen in further sections, the results of two different models conducted for the same correlations are consistent without some exceptions. Mean difference test results are presented from Table B.25 to Table B.30 for local industry and local country indexes in Appendix B.

3.4.3.1. Results for Local Industry Indexes

Some findings of local industry indexes from emerging countries differ from the full sample's findings. This can be because developed countries are more integrated into the global market than emerging countries. The results of local industry indexes from emerging countries are shown from Figure B.1 to Figure B.6 visually. Figure B.1 presents average pair-wise correlations. Average correlations of local industry returns appear to run around a constant line. There is a decrease in the value of average correlations after the year 1988. Figure B.2 shows average correlations against global market return. The tendency of average correlations to the negative values is seen considerably in the time series. Figure B.3 includes single-factor model implied correlations. There are some spikes in average correlations at some points especially between 1976 and 1988. The reason why the value of average correlations is almost zero until 2003, except for spikes, is that the crisis periods do not affect emerging countries like developed countries. Hot money flows cyclically to emerging markets after the crisis periods. Developed countries move together more than emerging countries. The global depreciation does not seem to affect emerging countries between 1991 and 1997. Figure B.5 shows average idiosyncratic correlations from a single-factor model. Average correlations fluctuate from 1973 to 1988. They extremely appear to run around a constant line after the year 1988.

As seen in the tables, the null hypothesis indicating that there is a unit root is rejected distinctively for the model without a constant term and linear trend for pair-wise correlations, single-factor model implied correlations and FF3F model implied correlations. Besides, the unit root hypothesis is not rejected according to the model with a constant term for idiosyncratic correlations from a single-factor model. The other results of local industry indexes are identical to the previous results as a whole. According to the majority of the results, the null hypothesis indicating that there is a unit root is rejected for the model with a constant term. This states that the time series is stationary.

Considering all the consequences, the overall result is that it makes sense to create a portfolio strategy across local industry indexes from emerging markets. Average correlations of local industry indexes have remained constant on average throughout the time series. Despite globalization, which can have increased correlations, international diversification is still important.

3.4.3.2. Results for Local Country Indexes

The findings of local country indexes from emerging markets are presented from Table B.13 to Table B.24, and Figure B.7 to Figure B.12 in Appendix B. Time series of average correlations have different situations in some figures. Figure B.7 shows average pair-wise correlations. The time series has fluctuations in the long run. Average correlations drop to below zero at some points of the time series from 1973 to 1988. Figure B.9 and Figure B.11 depict single-factor model for implied and idiosyncratic correlations. The beginning year of the time series is 1986 in these figures because of data availability for the relevant model. Since emerging countries are more isolated from the global market than developed countries, it is possible to see different results from the previous results for the figures of local country indexes from emerging countries.

In tables, the existence of the unit root hypothesis is not rejected for the model without a constant term and linear trend for all correlations. However, the null hypothesis of a unit root for the nonstationary series is rejected for the model with a constant term. The results are almost identical to the results of the full sample except for the model with a constant term for single-factor model implied correlations. The hypothesis testing the existence of unit root is not rejected at any significance level based on this model.

International investors seek to reduce the risk of portfolios based on their investment strategy. According to the findings, portfolio risk can be reduced by international diversification across local country indexes from emerging countries. International investors and portfolio managers can use local country indexes to obtain a successful international diversification strategy.

3.4.3.3. Mean Difference Results for Local Industry and Local Country Indexes

The results of the mean difference tests to compare local industry and local country indexes of emerging countries are shown from Table B.25 to Table B.30 in Appendix B. The findings of different average correlation measures are consistent except the findings of Table B.25 and Table B.29. According to the majority of the results, the null hypothesis of the mean difference test is rejected. Therefore, the mean correlation of local industry indexes is lower than the mean correlation of local country indexes according to the majority of results. Efficient international diversification opportunities can be more guaranteed for local industry indexes than local country indexes.

3.4.4. Mean Difference Results for Developed and Emerging Countries

The results of the same average correlation types are compared for developed and emerging countries. If the first decision is to diversify across local industry indexes, the next question is whether to diversify across industry indexes from developed or emerging countries. The results of mean difference tests for local industry indexes of developed and emerging countries are reported from Table 3.50 to Table 3.55.

The null hypothesis is not rejected at any significance level according to the results of Table 3.50 and 3.55. The mean correlation of local industry indexes from developed countries is lower than the mean correlation of local industry indexes from emerging countries according to the results of Table 3.54. According to the majority of results in which the hypothesis of the mean difference tests is rejected (Table 3.51, Table 3.52 and Table 3.53), the mean correlation of local industry indexes from developed countries is statistically higher than the mean correlation of local industry indexes from emerging countries. Therefore, diversifying through emerging markets rather than developed markets provides more benefits.

Table 3.50. Mean Difference Test Statistics between Pair-wise Correlations for Local Industry Indexes

Mean Correlation of Local Industry Indexes (Developed Countries)	Mean Correlation of Local Industry Indexes (Emerging Countries)	Mean Difference	t-Statistic	Prob.
0.197571	0.201985	-0.004414	-0.531096	0.5955

Table 3.51. Mean Difference Test Statistics between Correlations against Global Market Return for Local Industry Indexes

Mean Correlation of Local Industry Indexes (Developed Countries)	Mean Correlation of Local Industry Indexes (Emerging Countries)	Mean Difference	t-Statistic	Prob.
0.339106	0.198475	0.140631	14.115230	0.0000

Table 3.52. Mean Difference Test Statistics between Single-Factor Model Implied Correlations for Local Industry Indexes

Mean Correlation of Local Industry Indexes (Developed Countries)	Mean Correlation of Local Industry Indexes (Emerging Countries)	Mean Difference	t-Statistic	Prob.
0.136629	0.066443	0.070186	-11.30835	0.0000

Table 3.53. Mean Difference Test Statistics between FF3F Model Implied Correlations for Local Industry Indexes

Mean Correlation of Local Industry Indexes (Developed Countries)	Mean Correlation of Local Industry Indexes (Emerging Countries)	Mean Difference	t-Statistic	Prob.
0.166278	0.07713	0.08915	-11.24455	0.0000

Table 3.54. Mean Difference Test Statistics between Idiosyncratic Correlations from a Single-Factor Model for Local Industry Indexes

Mean Correlation of Local Industry Indexes (Developed Countries)	Mean Correlation of Local Industry Indexes (Emerging Countries)	Mean Difference	t-Statistic	Prob.
0.059982	0.155487	-0.095505	-13.188300	0.0000

Table 3.55. Mean Difference Test Statistics between Idiosyncratic Correlations from the FF3F Model for Local Industry Indexes

Mean Correlation of Local Industry Indexes (Developed Countries)	Mean Correlation of Local Industry Indexes (Emerging Countries)	Mean Difference	t-Statistic	Prob.
0.06499	0.061111	0.00388	-14.47398	0.1483

3.5. Conclusion

This chapter examines the time-series behavior of average correlations and the implications of this for the diversification strategies of international investors and portfolio managers. It uses correlation measures to evaluate whether diversification through local industries or local countries is more effective. The analyses are also performed for both developed and emerging markets to evaluate international diversification options in these two markets. If correlations do not rise over time, international diversification can still be applied to reduce portfolio risk whereas, if correlations do increase, international diversification will not be a useful risk reduction strategy for investors and portfolio managers. Finally, if international diversification still works, the chapter evaluates whether international diversification through local industries (countries) reduces risk more than countries (industries).

After calculating four kinds of correlations, unit root tests are conducted to analyze the behavior of average correlations over time. Then, mean difference tests are run to analyze whether diversification is more effective through local industries or local countries. Developed and emerging markets are also compared by mean difference tests.

The results show that average correlations fluctuate over time based on economic events especially crises according to visual inspection. Average correlations can be tested more formally by unit root and mean difference tests. There is a fluctuation in the time series of correlation measures. Moreover, average correlations of local industries are statistically lower than those of local countries. Therefore, international diversification still has benefits and more efficient diversification can be obtained through local industry indexes. Besides, international diversification is more effective through industry indexes of emerging markets rather than developed markets.

CHAPTER 4
CORRELATIONS AND INDEX RETURN PREDICTABILITY

4.1. Introduction

Correlation is an important factor for return estimation for investors and portfolio managers (Pollet and Wilson, 2010; Asness et al., 2020). Return correlations among international markets significantly determine investment strategy (Dutt and Mihov, 2013: 3). The main purpose of this chapter is to investigate the relationship between correlation and industry/country index returns. According to Markowitz's MPT, investors' strategies are affected by changes in correlation movements (Markowitz, 1952: 78). Accordingly, this chapter explores whether correlations have a role in estimating future index returns.

According to asset pricing theory, various factors explain future index return. It is a major topic that is regularly addressed. A correlation coefficient can be derived from asset pricing models. Covariance or correlation coefficient measures are used to form an optimal portfolio based on the Markowitz selection technique. According to MPT, the most efficient portfolio can be constructed by combining securities that are weakly correlated. The combination can be made in many ways (Best and Hlouskova, 2000: 197). Asset pricing models can be used to express correlation coefficients in terms of global and local factor betas. Different factor models have been used in the literature to account for different segmentation and integration degrees of markets. In segmented markets, only local factors affect the return on assets whereas only global factors affect returns on assets in integrated markets (Kearney and Lucey, 2004: 571).

Markowitz (1952) introduced MPT and interpreted the importance of portfolios, risk and correlations. CAPM, which was developed independently by Sharpe (1964), Lintner (1965) and Mossin (1966) based on portfolio theory, explains the relationship between expected return and risk factors (Fama and French, 1996: 1). Fama and French (1993) extended CAPM by adding two factors for book-to-market and size to develop the FF3F asset pricing model. The model explains stock returns through three factors:

market risk, the outperformance of small-cap stocks relative to large-cap stocks and the outperformance of high book-to-market stocks relative to low book-to-market companies.

This chapter investigates whether correlation measures can be used to estimate future index returns and an investment strategy based on correlations can be constructed. Firstly, monthly correlation measures are estimated for the sample period. Secondly, Fama-MacBeth regression analyses are performed using correlation estimates as inputs. Thirdly, sub-sample and sub-period analyses are conducted. Index returns are separately regressed on the different types of correlation estimates to evaluate whether the definition of correlation matters in explaining future index returns.

In this chapter, the full sample is expanded and the number of local stock market indexes is increased to 63 countries. The analyses are conducted separately for the local industry and local country indexes over the research period from July 1990 to October 2018. Firstly, monthly sample correlations, monthly implied correlations from the global FF3F model and monthly idiosyncratic correlations from the FF3F model are calculated using daily index-return data for each month over the research period. Secondly, monthly cross-sectional Fama-MacBeth (1973) regression analyses are conducted. Three different types of correlation variables are used in regression analyses with the same control variables. Thus, the chapter evaluates how correlation measures explain returns and which correlation measure affects returns more and determines whether these observations provide benefits for international investors in portfolio management.

The remainder of the chapter is organized as follows. Section 4.2 introduces the data and variables and relevant background information. Section 4.3 presents the methodology, specifically the correlation analyses, Fama-MacBeth regression analyses, and sub-sample and sub-period analyses. Section 4.4 presents and explains the results. Section 4.5 reaches some conclusions based on the findings.

4.2. Data

In this chapter, the content and time period of the data set are changed. Although the vast majority of data are downloaded from Datastream from January 1973 to December 2018, the data period is from July 1990 to October 2018, amounting to 340 months to ensure data availability for all variables used in this chapter. The start date of analysis is determined by the availability of FF3F data, which is available from July 1990 in Kenneth R. French Data Library. Treasury bill rates, which are used as monthly and daily risk-free rates, are also downloaded from Kenneth R. French Data Library.

Two different samples are used: local industry (local supersector) and local country (local stock-market) indexes. The global index is also used as an auxiliary set. A local stock-market index is consisting of local industry indexes in a particular country. Local industry classification is based on Industry Classification Benchmark (ICB) which is operated and managed by FTSE Group[2].

ICB follows the performance and evolution of industries, supersectors, sectors and subsectors over time. According to the classification of the ICB, companies are firstly split into subsectors according to their main activity. Subsectors are grouped into sectors. Similar sectors are combined into supersectors to determine some economic opportunities for investors. Then, similar supersectors are grouped to form industries (Umutlu, 2015: 62).

Supersector classifications on the ICB are used for industry representation. The data set consists of 19 supersector indexes from 63 countries. Since some countries do not have all 19 industry indexes in Datastream, 1078 industry indexes exist totally for analyses rather than 1197 (=19x63).

Index returns of countries are also provided by Datastream. 24 of 63 countries are developed countries. These countries are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hong Kong, Ireland, Italy, Japan, Luxemburg, Netherland, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, United Kingdom and the United States. The remaining 39 countries are emerging countries. These countries are Argentina, Bahrain, Brazil, Bulgaria, Chile, China, Colombia, Croatia, Cyprus, Czech Republic, Egypt, Hungary, India, Indonesia, Israel, Jordan, Kuwait, Malaysia, Malta, Mexico, Morocco, Nigeria, Oman, Pakistan, Peru, Philippine, Poland, Qatar, Romania, Russia, Slovenia, South Africa, South Korea, Sri Lanka, Taiwan, Thailand, Turkey, United Arab Emirates and Venezuela.

[2] For more details about the ICB, see www.ftserussell.com.

Table 4.1. Descriptive Statistics for Local Industry Indexes

Supersectors	Mean	Standard Deviation
Automobiles and parts	0.0111	0.1095
Banks	0.0160	0.1386
Basic resources	0.0117	0.1209
Chemicals	0.0090	0.1060
Construction and materials	0.0131	0.1088
Financial services	0.0136	0.1350
Food and beverage	0.0115	0.0929
Health care	0.0258	0.3006
Industrial goods and services	0.0102	0.0965
Insurance	0.0133	0.1044
Media	0.0134	0.1360
Oil and gas	0.0096	0.1076
Personal and household goods	0.0091	0.1057
Real estate	0.0112	0.1013
Retail	0.0104	0.0993
Technology	0.0104	0.1032
Telecommunications	0.0103	0.1100
Travel and leisure	0.0124	0.1149
Utilities	0.0268	0.2197

Table 4.1 presents the means and standard deviations of monthly returns of 19 supersector indexes. The values in Table 4.1 are obtained in the following way: the basic statistics are calculated for local supersector indexes, using time-series data of local supersector indexes from each country. Then, the cross-sectional averages of the time-series statistics across countries are calculated for each supersector index. Table 4.2 presents the time-series information for the means and standard deviations for monthly returns of 63 stock-market indexes. The research period is from July 1990 to October 2018 for both sets of indexes.

Table 4.2. Descriptive Statistics for Local Country Indexes

Stock-Markets	Mean	Standard Deviation	Stock-Markets	Mean	Standard Deviation
Argentina	0.0074	0.0981	Malta	0.0053	0.0491
Australia	0.0097	0.0594	Mexico	0.0123	0.0809
Austria	0.0063	0.0633	Morocco	0.0103	0.0482
Bahrain	0.0038	0.0362	Netherland	0.0087	0.0569
Belgium	0.0078	0.0542	New Zealand	0.0095	0.0586
Brazil	0.0105	0.0992	Nigeria	0.0024	0.0724
Bulgaria	0.0170	0.0995	Norway	0.0096	0.0732
Canada	0.0088	0.0540	Oman	0.0055	0.0470
Chile	0.0124	0.0664	Pakistan	0.0100	0.0902
China	0.0131	0.0975	Peru	0.0108	0.0646
Colombia	0.0102	0.0792	Philippine	0.0094	0.0811
Croatia	0.0068	0.0791	Poland	0.0070	0.1014
Cyprus	0.0060	0.1256	Portugal	0.0055	0.0625
Czech Rep.	0.0118	0.0854	Qatar	0.0117	0.0845
Denmark	0.0098	0.0542	Romania	0.0149	0.1376
Egypt	0.0086	0.0859	Russia	0.0162	0.1249
Finland	0.0118	0.0844	Singapore	0.0075	0.0645
France	0.0087	0.0577	Slovenia	0.0056	0.0599
Germany	0.0074	0.0587	South Africa	0.0092	0.0757
Greece	0.0026	0.1008	South Korea	0.0097	0.1007
Hong Kong	0.0117	0.0704	Spain	0.0085	0.0658
Hungary	0.0119	0.1040	Sri Lanka	0.0084	0.0754
India	0.0127	0.1001	Sweden	0.0102	0.0708
Indonesia	0.0073	0.1017	Switzerland	0.0093	0.0478
Ireland	0.0081	0.0608	Taiwan	0.0077	0.0929
Israel	0.0076	0.0658	Thailand	0.0109	0.1000
Italy	0.0055	0.0692	Turkey	0.0139	0.1495
Japan	0.0032	0.0583	U.A.E.	0.0121	0.0805
Jordan	0.0021	0.0459	The U.K.	0.0074	0.0486
Kuwait	0.0053	0.0542	The U.S.	0.0092	0.0434
Luxemburg	0.0087	0.0538	Venezuela	0.0363	0.2402
Malaysia	0.0082	0.0784			

Three types of correlation measures such as sample correlations, implied correlations from the FF3F model and idiosyncratic correlations from the FF3F model are used. Daily return data for local industry/country indexes and global market index are used to calculate sample correlations for each month. To estimate implied and idiosyncratic correlations, the FF3F model is used where returns of local industry/country indexes are dependent variables and Fama-French three factors are independent variables.

10 control variables are used in regression analyses. These variables are 'earnings before interest taxes depreciation and amortization/enterprise value' (*EBITDA/EV*), market value (*MV*), return on equity (*ROE*), earnings-to-price (*EP*), operating profit (*OP*), investment instruments (*INV*), net share issuance (*NSI*), momentum (*MOM*), idiosyncratic volatility (*IVOL*) and correlation variable (*COR*). One-month ahead index returns are regressed on correlation measures and control variables. Three correlation variables are not simultaneously included in the regression equation.

Some control variables that are frequently used in the literature are directly downloaded from Datastream whereas some control variables are calculated using raw data. Monthly data for *MV*, *ROE*, *EP* and the ratio of *EBITDA* to *EV* are directly downloaded and retrieved for local industry/country indexes. The variable of (*EBITDA/EV*) shows a financial ratio that measures the return on investment. *EBITDA* indicates earnings before interest taxes depreciation and amortization, *EV* indicates enterprise value for local industry/country indexes. *MV* indicates the market value of local industry/country indexes and refers to market capitalization. *ROE* is a profitability measure and indicates the return on equity on local industry/country indexes. *EP* indicates earnings-to-price ratio and is the inverse of the price-earnings ratio (Basu, 1977, Banz, 1981; 1983; Haugen and Baker, 1996; Hou et al., 2015; Zaremba, 2016).

On the other hand, *OP*, *INV*, *NSI*, *MOM* and *IVOL* variables are calculated for each month using raw data as defined below. "$OP_{i,t}$" indicates operating profit which is calculated by dividing "($EBIT_{i,T-1}$ - $I_{i,T-1}$)" by "$BE_{i,T-1}$" in year "$T-1$" and remains constant in year "T" in which month "t" belongs to. "$OP_{i,t}$" is as expressed in Equation (4.1):

$$OP_{i,t} = \frac{EBIT_{i,T-1} - I_{i,T-1}}{BE_{i,T-1}} \tag{4.1}$$

where the values of "$EBIT_{i,T-1}$", "$I_{i,T-1}$" and "$BE_{i,T-1}$" belong to June of year "$T-1$". "$EBIT_{i,T-1}$" indicates earnings before interest and taxes on local industry/country "i" of previous year's June, the value of "$I_{i,T-1}$" represents interest value and is calculated by dividing the value of "$EBIT_{i,T-1}$" by interest charge coverage of previous year's June and "$BE_{i,T-1}$" represents book equity of previous year's June (Fama and French, 2015: 3).

"$INV_{i,t}$" shows investment performance and is defined as the ratio of "($TA_{i,T-1}$ - $TA_{i,T-2}$)" to "$TA_{i,T-2}$" in month "t". It is demonstrated as follows (Fama and French, 2015: 3):

$$INV_{i,t} = \frac{TA_{i,T-1} - TA_{i,T-2}}{TA_{i,T-2}} \tag{4.2}$$

where "$TA_{i,T-1}$" indicates total assets in June of the previous year and "$TA_{i,T-2}$" indicates total assets in June of the year "T-2". The change in total assets from June of the year "T-2" to June of the year "T-1" is divided by total assets in June of the year "T-2" in Equation (4.2). "$INV_{i,t}$" remains constant for the months from the previous year's June until June of year "T".

"$NSI_{i,t}$" indicates net share issuance which is defined as the net change in shares outstanding and is calculated in the following way (Fama and French, 2008: 1668):

$$NSI_{i,t} = \ln\left(\frac{MV_{i,t}}{MV_{i,t-k}}\right) - \ln\left(\frac{PI_{i,t}}{PI_{i,t-k}}\right) \tag{4.3}$$

where "$MV_{i,t}$" indicates the market value in month "t" and "$PI_{i,t}$" indicates the price index in month "t". "$NSI_{i,t}$" is calculated over the last month, i.e., k=1.

"$MOM_{i,t}$" indicates momentum performance and is calculated as the cumulative monthly return using returns of the previous n-months period. It represents a measure of the price change at a continuous rate (Jegadeesh and Titman, 1993; Carhart, 1997; Asness et al., 2013; Hühn and Scholz, 2018):

$$MOM_{i,t} = \left(\frac{RI_{i,t-1}}{RI_{i,t-11}}\right) - 1 \tag{4.4}$$

where "$RI_{i,t-1}$" indicates the return index on local industry/country "i" in month "t-1", which adjust the prices for dividends and stock splits and "$RI_{i,t-11}$" indicates the return index on local industry/country "i" in month "t-11".

Idiosyncratic volatility is a part of the total volatility of index returns which is not explained by market factors (Bali et al., 2011; Li and Kumar, 2017: Umutlu, 2019). "$IVOL_{i,t}$" indicates the idiosyncratic volatility and is calculated using residuals from ICAPM. The residuals are obtained from Equation (4.5).

$$R_{idt} = \alpha_{it} + \beta_{1i} R_{Gdt} + \varepsilon_{idt} \tag{4.5}$$

where "R_{idt}" indicates the daily excess return on local industry/country "i" on day "d" in month "t", "R_{Gdt}" indicates the daily excess return on the global market, "α_{it}" indicates the alpha value of local industry/country "i", "β_{1i}" -beta- indicates the regression coefficient and "ε_{idt}" indicates the error term, i.e., residual term. The regression equation is estimated for each local industry/country index within each month using daily data. In other words, returns of the local industry/country indexes are regressed on the global risk factor based on Equation (4.5). After daily residual terms are obtained within each month from Equation (4.5), the residuals are used to obtain the idiosyncratic volatility as follows:

$$IVOL_{it} = \sqrt{\sum_{d=1}^{n} \varepsilon_{idt}^2} \quad (4.6)$$

where "$IVOL_{it}$" indicates the idiosyncratic volatility of local industry/country "i" in month "t", "n" is the number of trading days in month "t" and "ε_{idt}" indicates the residual term on local industry/country "i" on day "d" in month "t".

4.3. Methodology

Firstly, three correlation measures are calculated for local industry and local country indexes. Secondly, Fama-MacBeth regression analyses are performed across indexes using correlation estimates as inputs. Thirdly, sub-sample and sub-period analyses are conducted using new samples to examine the results.

4.3.1. Correlation Analyses

4.3.1.1. Sample Correlations

Sample covariance is a simple covariance of index returns. It is independent of a factor model and is directly calculated on index return. Sample covariance has two components as implied covariance (systematic covariance) and idiosyncratic covariance (unsystematic covariance). Sample correlation, which is derived from sample covariance, is a simple correlation between returns of local industry/country indexes and the global market.

Monthly sample correlation estimates are computed using daily return data for 340 months in the research period. Daily index returns of local industries and local countries are used to estimate the monthly correlations between the return on a local industry/country and the return on the global market. Therefore, each local industry/country correlates with the global market separately. For each month, the number of correlations is equal to the number of local industries/countries existing in a month. Equation (4.7) is used to calculate sample correlations.

$$\rho_{iG,sample} = \frac{\sigma_{iG}}{\sigma_i \sigma_G} \qquad (4.7)$$

where "$\rho_{iG,sample}$" indicates the sample correlation coefficient between the return on local industry/country "i" and the return on the global market, "σ_{iG}" is the sample covariance demonstrating the covariance between local industry/country "i" and the global market, "σ_i" indicates the standard deviation of returns on local industry/country "i", "σ_G" indicates the standard deviation of global market returns.

Sample covariance and implied covariance are exactly equal to each other for a simple regression in CAPM. The beta is already calculated from sample covariance and is a forecaster of implied correlations. Therefore, implied correlations from CAPM are not estimated within the scope of correlation analyses in this chapter. The simple regression, which is stated in Equation (4.8), is constructed according to the general statistical fact of CAPM and is not performed in this chapter because of the equality of sample covariance and implied covariance in CAPM.

$$R_{it} = \alpha_i + \beta_{iG} R_{Gt} + \varepsilon_{it} \qquad (4.8)$$

where "R_{it}" indicates the daily excess return on local industry/country "i" on day "t" within month "T", "R_{Gt}" indicates the daily excess return on the global market, "α_i" indicates the alpha value of local industry/country "i", "β_{iG}" -beta- indicates the regression coefficient which will also be used as the correlation coefficient between the return on the global market and the return on local industry/country "i", "ε_{it}" indicates the error term. The beta estimates, which come from Equation (4.8), are used in Equation (4.9) to calculate the correlation coefficient according to implied correlations from CAPM. Equation (4.9) is derived from the calculation of implied covariance.

$$\rho_{iG} = \frac{\beta_{iG} \sigma_G}{\sigma_i} \qquad (4.9)$$

where "ρ_{iG}" is the implied correlation coefficient demonstrating the correlation coefficient between local industry/country "i" and the global market.

Equation (4.9) is obtained by inserting Equation (4.10) into Equation (4.11). The regression coefficient in the univariate regression is demonstrated as follows:

$$\beta_{iG} = \frac{cov(R_i,R_G)}{\sigma_G^2} \tag{4.10}$$

where "$cov(R_i, R_G)$" indicates the covariance between local industry/country "i" and the global market and "σ_G^2" indicates the variance of the global market.

The relationship between the covariance and the correlation coefficient is shown in Equation (4.11). This is the general covariance term and the correlation coefficient is calculated by normalizing the covariance with standard deviations (Pearson, 1896: 252).

$$\rho_{iG} = \frac{cov(R_i,R_G)}{\sigma_i\sigma_G} \tag{4.11}$$

where $cov(R_i, R_G)$ is formulated in terms of the correlation coefficient, "ρ_{iG}", between local industry/country "i" and the global market; and the standard deviations of them, "σ_i" and "σ_G".

As it is mentioned before, implied correlations are not estimated in this chapter because of the equality of sample covariance and implied covariance. It will be proved below:

Implied covariance ($cov_{model}(R_i, R_G)$)=$\beta_{iG}\sigma_G^2$ (4.12)

Implied covariance is demonstrated in Equation (4.12). However, "β_{iG}" is already calculated from sample covariance ("$cov(R_i, R_G)$") in simple regression (univariate) by definition of Equation (4.13). "β_{iG}" indicates the beta of local industry/country "i" from CAPM for a single-factor model. Therefore, implied covariance ("$cov_{model}(R_i, R_G)$") is obtained based on "β_{iG}", which is already calculated from sample covariance. The sample covariance is directly calculated (not from the model) as shown in Equation (4.13).

Sample covariance ($cov(R_i, R_G)$)= $\beta_{iG}\sigma_G^2$ (4.13)

It is seen that the right sides of Equation (4.12) and Equation (4.13) are equal to each other as both equations are combined. Thus, implied covariance and sample covariance are equal to each other ($cov_{model}(R_i, R_G)=cov(R_i, R_G)$) in a CAPM framework. This equality holds for only CAPM, not for other models. In such a case, there is no point in calculating idiosyncratic correlation in a single-factor model. That's why only the FF3F model is used to estimate idiosyncratic correlations.

Sample covariance has two components as implied covariance and idiosyncratic covariance. Different implied and idiosyncratic correlation estimates can be calculated from various factor models. In this chapter, implied correlations and idiosyncratic correlations from the global FF3F model will be estimated as parts of sample correlations.

4.3.1.2. Implied Correlations from the Global FF3F Model

The Fama-French (1993) three-factor model is represented as shown in Equation (4.14).

$$R_{it} = \alpha_i + \beta_{i1} R_{G_t} + \beta_{i2} SMB_t + \beta_{i3} HML_t + \varepsilon_{it} \quad (4.14)$$

where "β_{i1}" -beta- indicates the factor coefficient of the return on the global market, "β_{i2}" -beta- indicates the factor coefficient of SMB. "SMB_t" is the difference in returns on small firms and large firms during "t" and controls for size effect depending on a market capitalization. "β_{i3}" -beta- indicates the factor coefficient of HML. "HML_t" is the difference in returns of firms with high book-to-market value ratios and the returns of firms with low book-to-market value ratios.

Each local industry and local country index is regressed on three factors. Beta estimates are obtained separately for each local industry and local country index within a month. The next step is to calculate the covariance between the return on local industries/countries and the return on the global market. Equation (4.15) demonstrates implied covariance, i.e. systematic covariance, between the return on local industry/country "i" (R_{it}) and return on the global market (R_{G_t}).

$$cov\,(R_{it}, R_{G_t}) = cov\,(\alpha_i + \beta_{i1} R_{G_t} + \beta_{i2} SMB_t + \beta_{i3} HML_t + \varepsilon_{it};\ R_{G_t}) \quad (4.15)$$

Equation (4.16) and Equation (4.17) follow from Equation (4.15):

$$cov\,(R_{it}, R_{G_t}) = cov\,(\beta_{i1} R_{G_t},\ R_{G_t}) + cov\,(\beta_{i2} SMB_t, R_{G_t}) + cov(\beta_{i3} HML_t, R_{G_t}) \quad (4.16)$$

$$cov\,(R_{it}, R_{G_t}) = \beta_{i1} \sigma_G^2 + \beta_{i2} cov\,(SMB_t, R_{G_t}) + \beta_{i3} cov(HML_t, R_{G_t}) \quad (4.17)$$

The betas can be taken out of covariance operator and $cov\,(R_{G_t},\ R_{G_t})$ corresponds to "σ_G^2", the variance of the global market, in Equation (4.17). Equation (4.18) represents a general statistical fact and shows that the covariance between the return on local industry/country "i" and return on the global market is the product of the correlation coefficient between indexes and their standard deviations.

$$cov\ (R_{it}, R_{G_t}) = \rho_{iG}\sigma_i\sigma_G \tag{4.18}$$

Equation (4.19) is obtained by inserting the right side of Equation (4.18) into the left side of Equation (4.17) because Equation (4.17) and Equation (4.18) represent the same value ($cov\ (R_{it}, R_{G_t})$).

$$\rho_{iG}\sigma_i\sigma_G = \beta_{i1}\sigma_G^2 + \beta_{i2}cov\ (SMB_t, R_{G_t}) + \beta_{i3}cov(HML_t, R_{G_t}) \tag{4.19}$$

where "$cov\ (SMB_t, R_{G_t})$" indicates the covariance between the size factor and return on the global market, "$cov(HML_t, R_{G_t})$" indicates the covariance between the value factor and return on the global market.

Equation (4.20) is obtained by dividing all parts of Equation (4.19) by "$\sigma_i\sigma_G$". Thus, implied correlations from the FF3F model are calculated. Betas which are obtained from Equation (4.14) are used in Equation (4.20).

$$\rho_{iG,implied} = \frac{\beta_{i1}\sigma_G}{\sigma_i} + \frac{\beta_{i2}cov\ (SMB_t, R_{G_t})}{\sigma_i\sigma_G} + \frac{\beta_{i3}cov(HML_t, R_{G_t})}{\sigma_i\sigma_G} \tag{4.20}$$

where " $\rho_{iG,implied}$ " indicates implied correlation coefficient between local industry/country "i" and the global market. The other variables are as defined before. As a result of this process, monthly implied correlations from the FF3F model for each local industry/country are obtained using daily data.

4.3.1.3. Idiosyncratic Correlations from the Global FF3F Model

Stock return movements can be investigated through a linear factor model. Covariance between asset returns implied from a linear factor model is formed from time-varying factor exposures (betas), time-varying factor volatilities and time-varying idiosyncratic volatilities (Bunzel and Vogelsang, 2005: 6).

The value of idiosyncratic covariance is computed by subtracting implied covariance from sample covariance. In this chapter, idiosyncratic correlations are estimated from the global FF3F model, not from CAPM, because implied covariance (systematic covariance) and sample covariance are exactly equal to each other in CAPM. In such a case, the value of idiosyncratic covariance is zero in the CAPM setting.

Idiosyncratic correlations of local industry and local country indexes are estimated over time based on idiosyncratic covariances. Sample correlations and implied correlations from the FF3F model are calculated and the findings are used to estimate idiosyncratic correlations. Correlations of local industry and local country indexes are explained by some risk exposures and idiosyncratic covariances in this section. An idiosyncratic covariance is stated by subtracting a function of factor loadings from the covariance between local industry/country return and global market return as shown below (Bekaert et al., 2009: 2597):

$$cov_{idiosyncratic,t} = cov_{sample,t} - cov_{implied,t} \tag{4.21}$$

where "$cov_{idiosyncratic,t}$" indicates the residual covariance, "$cov_{sample,t}$" indicates sample covariance demonstrating the covariance between local industry/country "i" and the global market, "$cov_{implied,t}$" indicates implied covariance derived from the global FF3F model. The idiosyncratic covariance ($cov(e_{i1}, e_{i2})$) should be zero if the factor model fully identifies index return movements.

Factors, which are used in the FF3F model, are not orthogonal to each other as pair-wise correlations between them are not equal to zero. Implied covariance between each local industry/country and the global market is computed and there is only one covariance estimation value for one index within a month. An estimation error may occur (it is very likely that epsilon will be nonzero). Hence, sample covariance and implied covariance differentiate from each other and idiosyncratic covariance with a nonzero value emerges.

Idiosyncratic correlation from the global FF3F model is defined as the ratio of idiosyncratic covariance to the product of standard deviations as follows:

$$\rho_{iG,idio} = \frac{cov_{idiosyncratic}}{\sigma_i \sigma_G} \tag{4.22}$$

where "$\rho_{iG,idio}$" indicates idiosyncratic correlation coefficient between the return on local industry/country "i" and the return on the global market, "$cov_{idiosyncratic}$" is idiosyncratic covariance demonstrating the covariance between local industry/country "i" and global market, "σ_i" indicates the standard deviation of local industry/country "i", "σ_G" indicates the standard deviation of the global market.

Betas induce short-term changes in correlation stemming from globalization (Bekaert et al., 2009: 2597). Correlations of local industry and local country indexes could increase due to increasing betas of global factors because of the globalization process or decrease in idiosyncratic volatilities (Fratscher, 2002: 2). After all types of correlations are computed monthly in correlation analyses, they will be used as return predictors in Fama-MacBeth regression analyses.

4.3.2. Fama-MacBeth Regression Analyses

CAPM theoretically reveals the existence of the relationship between systematic risk and stock return (Jagannathan and Wang, 1996: 4). This model is valid under various assumptions (Fama and French, 1996: 1). The first experimental tests for this model were performed by Black et al. (1972) and then by Fama and MacBeth (1973). Fama and MacBeth (1973) developed methodological approaches to the relationship between systematic risk and stock return. Besides, they investigated whether other variables explain returns. The two-parameter empirical study which was developed in 1973 by Fama and MacBeth (1973) is a significant study on empirical tests of CAPM (Fama and MacBeth, 1973: 610). Fama and Macbeth (1973) applied a model using two-stage regression analysis in the U.S. Stock Market and concluded that the model is valid. Moreover, they examined the relationship between stock returns and risk with time series and cross-sectional regression analyses using the monthly rate of return of all stocks.

In this chapter, it is analyzed whether the correlation variables as return predictors estimate future index returns after controlling for several variables. Within the scope of this, cross-sectional Fama-MacBeth regressions are performed on several variables for each month across indexes. Fama-MacBeth regression analyses are separately performed across two samples.

$$R_{i,t+1} = \alpha_0 + \beta_{1,t}COR_{i,t} + \beta_{2,t}\left(\frac{EBITDA_{i,t}}{EV_{i,t}}\right) + \beta_{3,t}, MV_{i,t} + \beta_{4,t}ROE_{i,t} + \beta_{5,t}EP_{i,t} + \beta_{6,t}OP_{i,t} + \beta_{7,t}INV_{i,t} + \beta_{8,t}NSI_{i,t} + \beta_{9,t}MOM_{i,t} + \beta_{10,t}IVOL_{i,t} + \varepsilon_{i,t} \quad (4.23)$$

where "$R_{i,t+1}$" indicates the monthly excess return on local industry/country "i" in month "$t+1$" and "β_t", indicate the regression coefficients in the month "t" for each of the variables. One-month ahead index returns are regressed on 10 variables in Equation (4.23). Monthly beta values are obtained for each local industry/country index. Control variables that are widely used in the literature are included in the regression equation.

"$COR_{i,t}$" indicates a correlation variable and three different types of correlation variables are used in Equation (4.23) separately. Fama-MacBeth regressions are re-estimated for alternative correlations, which are not included in the same regression. In such a case, Equation (4.23) has three specifications having potentially a maximum number of variables of 10 (9 control variables and one type of correlation variable).

The first one has 9 control variables and the variable of sample correlation. The second one has the same control variables and the variable of implied correlation from the FF3F model. The last specification includes the variable of idiosyncratic correlation from the FF3F model.

Time series of month-by-month values of beta coefficients are estimated for each variable from cross-sectional regressions of all index returns on 10 variables for each month. Then simple averages of month-by-month values of beta coefficients are calculated. These average beta coefficients are also used in the calculation of the t-statistics. Since each mean value is computed using beta coefficients for many months, the distributions of the averages of month-by-month beta coefficients are likely to be close to normal. Then, t-statistics are calculated as follows (Fama and MacBeth, 1973: 619):

$$t(\bar{\beta}_j) = \frac{\bar{\beta}_j}{s(\beta_j)/\sqrt{n}} \quad (4.24)$$

j=1, 2…10

where "$t(\bar{\beta}_j)$" is t-statistics to test the null hypothesis that the beta estimate is equal to zero, "$\bar{\beta}_j$" is the average of month-by-month beta coefficient estimates, "$s(\beta_j)$" is the standard deviation of the monthly estimates and "n" is the number of months in the period. Since Equation (4.23) contains 10 beta coefficients, "j" takes values from 1 to 10 in Equation (4.24).

The following hypothesis is tested based on t-statistics obtained from Equation (4.24):

$H_0 : \bar{\beta}_j = 0$

$H_A : \bar{\beta}_j \neq 0$

The null hypothesis states that the mean beta value is not statistically different from zero. The alternative hypothesis states that the mean beta value is nonzero. If the null hypothesis is rejected, then the variable, to which the beta belongs, will have explanatory power on return and there will be a relationship between return and that variable.

4.3.3. Sub-Sample and Sub-Period Analyses

The full sample is divided into sub-samples and sub-periods to evaluate the relation between correlation and index returns using alternative samples. Cross-sectional Fama-MacBeth regressions, which are conducted for the full sample, are also performed within sub-sample and sub-period analyses across both local industry and local country indexes. The explanatory power of correlation estimates on index returns is analyzed also for these alternative samples.

4.3.3.1. Sub-Sample Analyses

Sub-sample analyses are conducted for three groupings: i) developed vs emerging markets, ii) big vs small markets, and iii) segmented vs integrated markets. Firstly, the full sample is split into two developed and emerging markets. Sub-sample of developed countries includes 24 countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hong Kong, Ireland, Italy, Japan, Luxemburg, Netherland, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, United Kingdom and the United States. Sub-sample of emerging countries includes 39 countries: Argentina, Bahrain, Brazil, Bulgaria, Chile, China, Colombia, Croatia, Cyprus, Czech Republic, Egypt, Hungary, India, Indonesia, Israel, Jordan, Kuwait, Malaysia, Malta, Mexico, Morocco, Nigeria, Oman, Pakistan, Peru, Philippine, Poland, Qatar, Romania, Russia, Slovenia, South Africa, South Korea, Sri Lanka, Taiwan, Thailand, Turkey, United Arab Emirates and Venezuela. Secondly, the full sample is divided into two sub-parts as big and small markets according to market value. The median of the market value of indexes is calculated for all indexes trading in a month. If the market value of an index is greater than the median market value in a month, the index enters into the big market sample for that month. Otherwise, the index enters into the small market sample for that month. One small and one big market sample are obtained over months. The number of indexes in each sample changes from month to month. Thirdly, the full sample is classified into segmented vs integrated markets. This classification is based on the segmentation measure, *SEG*, characterizing the degree of segmentation at the industry and country level (Bekaert et al., 2011: 3844). To construct the *SEG* variable, the monthly earnings yield of each global industry, *EY*, are calculated first. The EY of global industry portfolios are calculated as the value-weighted average of 19 local industries across countries. More specifically, *EY* values of 19 global industries are calculated for each month as follows:

$$EY_{w,j,t} = \frac{\sum_{i=1}^{N} EY_{i,j,t} MV_{i,j,t}}{\sum_{i=1}^{N} MV_{i,j,t}} \tag{4.25}$$

where "$EY_{w,j,t}$" indicates earnings yield of global industry "j" in month "t", "$EY_{i,j,t}$" indicates earnings yield of local industry "j" in the country "i" in month "t" and "$MV_{i,j,t}$" indicates the market value on local industry "j" in month "t", "N" indicates the number of countries in month "t". The market values of industries are used to determine the industry weights, "$IW_{i,j,t}$". Therefore, the value-weighted average of "$EY_{i,j,t}$" values are calculated across each local industry portfolio of 63 countries by weighing each industry with the market value of that industry. "$EY_{w,j,t}$" variable is calculated for each 19 global industry for each month. "$EY_{w,j,t}$" variables are used as inputs to compute the *SEG* variable.

Bekaert et al. (2011) developed the "$SEG_{i,t}$" variable as the weighted sum of local and global industry valuation differentials and use the measure as a degree of equity market segmentation for a country based on industries (Bekaert et al., 2011: 3844). The variable is computed for country segmentation as follows:

$$SEG_{i,t} = \sum_{j=1}^{N} IW_{i,j,t} \left| EY_{i,j,t} - EY_{w,j,t} \right| \tag{4.26}$$

where "N" indicates the number of industries in each country and each country is a portfolio of "N" industries, "$IW_{i,j,t}$" indicates the value-weight of industry "j" in the country "i" and is calculated according to the market value of industry "j" in the country "i", "$EY_{i,j,t}$" is the inverse of the price-earnings ratio, "$EY_{w,j,t}$" indicates earnings yield of global industry (market). The variable of "$\left| EY_{i,j,t} - EY_{w,j,t} \right|$" indicates the absolute value of the difference between valuation ratios of industry "j". Monthly global "$EY_{w,j,t}$" values of each industry "j" are subtracted from "$EY_{i,j,t}$" values of each industry "j" in a country "i".

In addition, industry segmentation is defined as the equal-weighted cross-sectional average of the absolute difference between local industry and global industry valuation across countries. For industry segmentation, "N" in Equation (4.26) indicates the number of countries in month "t", "i" shows the industry index, "j" shows the country index, $IW_{i,j,t}$" indicates the equal-weighted of country "j". In summary, the *SEG* variable is constructed for 63 countries to track country segmentation and 19 industries to track industry segmentation. Local earnings yields and portfolio weights are calculated for each industry and country.

Median values of *SEG* measures of 19 industries are obtained for each month. Median *SEG* values, which are constructed for industries, exist as much as different local industry portfolios available in a month. There can be up to 19 median *SEG* values for industries in a month. SEG measures above and below median SEG value are analyzed within each industry type for each month. On the other hand, there is just one median *SEG* value for countries in a month. *SEG* measures above and below median *SEG* value are analyzed within all local countries for each month. Industries/countries, which have an above-median *SEG* value, are included in the sub-sample of segmented markets for each month. Industries/countries having a below-median *SEG* value are collected in the sub-sample of integrated markets for each month. The number of industries/countries in each sample changes month to month due to changes in segmentation over time.

4.3.3.2. Sub-Period Analyses

In this chapter, sub-period analyses are conducted through three methods: sub-period analyses with bull vs bear markets, with markets based on high vs low volatility and with markets based on recessionary vs expansionary period. Firstly, the full sample is split into two sub-parts for each month according to bull vs bear markets. Asset prices rise in a bull market whereas they fall in a bear market. The decomposition is based on the return on the global market over months. If the return on the global market is zero or positive in a month, all indexes trading in that month will be in the bull market sample. If the return on the global market is negative in a month, all indexes trading in that month will be in the bear market sample. One bull and one bear market sample are obtained over months. Secondly, the full sample is divided into two sub-parts based on high vs low volatility. The analyses are performed according to the daily return on global market indexes. Monthly standard deviations of returns on global market indexes are computed using daily data. The median value of the standard deviations is obtained over months. Indexes of high volatility months are grouped as a sub-sample when the standard deviation of a month is above the median value. Indexes of low volatility months are grouped as a sub-sample when the standard deviation of a month is below the median value. Thirdly, the full sample is grouped into two sub-periods based on recessionary vs expansionary period. The analyses are performed according to monthly recession indicators for the United States provided by the National Bureau of Economic Research (NBER). Time series represent periods of expansion and recession (Federal Reserve Bank of St. Louis, 2020). This data set shows when the economy grows and shrinks over months. Sub-periods are formed over recession and expansion months.

4.4. Preliminary Results

4.4.1. Results for Correlation Analyses and Fama-MacBeth Index-Level Regressions

Table 4.3 presents the results of Fama-MacBeth index-level cross-sectional regressions for local industry (supersector) and local country (stock-market) indexes. Panel A presents the results for local industry indexes and Panel B shows the results for local country indexes. The time-series averages of coefficient estimates and R^2 values from monthly cross-sectional regressions are reported in the table. The t-statistics are provided in parentheses. Significance levels at 1%, 5% and 10% are denoted as ***, ** and *, respectively. There are three regression specifications in each panel. The first specification includes sample correlation as the correlation measure and the remaining 9 control variables. The second specification includes implied correlation from the FF3F model along with the control variables. In the last specification, correlation measure is the idiosyncratic correlation from the FF3F model.

For local industry indexes, the average coefficient of sample correlation is -0.0056 and significantly different from zero at 10% significance level with a t-statistic of -1.83 as shown in Panel A of Table 4.3. Thus, there is a significantly negative relationship between sample correlation and future returns. Sample correlation is a forecaster of future index returns. On the other hand, average coefficients of implied and idiosyncratic correlation from the FF3F model have insignificant coefficients with t-statistics of -1.37 and -0.57, respectively. The components of sample correlation do not affect the return. *EBITDA/EV*, *MV*, *EP*, *OP*, *MOM* and *IVOL* are positively related to return whereas *INV* is negatively related for all three regression specifications.

Panel B of Table 4.3 demonstrates the results for local country indexes. All average coefficients on correlation measures are insignificant. T-statistics for average coefficients of sample correlation, implied and idiosyncratic correlation from the FF3F model are -1.19, -0.98 and -0.08, respectively. Overall, the average coefficient of sample correlation is significantly different from zero for the sample of local industry indexes whereas coefficients on any correlation measure are not distinguished from zero for local country indexes.

As industry indexes with negative correlations are expected to earn higher returns, international diversification across local industry indexes rather than local country indexes seems more beneficial for international investors. The results are consistent with the results of Chapter Three showing that mean correlations of local industry indexes are lower than those of local country indexes.

Table 4.3. Fama-MacBeth Index-Level Regressions

Panel A: Local Supersector Indexes

Sample correlation	*Implied correlation*	*Idio correlation*	*EBITDA/EV ratio*	*MV*	*ROE*	*EP*	*OP*	*INV*	*NSI*	*MOM*	*IVOL*	R^2
-0.0056*	-	-	0.0074***	0.0067**	-0.0008	0.0342***	0.0026*	-0.0011**	-0.0132	0.0109***	0.2019***	0.1675
(-1.83)	-	-	(2.82)	(2.42)	(-0.35)	(3.99)	(1.88)	(-2.28)	(-0.95)	(4.82)	(6.70)	
-	-0.0041	-	0.0074***	0.0064**	-0.0007	0.0343***	0.0028**	-0.0012**	-0.0127	0.0108***	0.2032***	0.1669
-	(-1.37)	-	(2.78)	(2.29)	(-0.33)	(3.99)	(1.98)	(-2.33)	(-0.92)	(4.70)	(6.79)	
-	-	-0.0072	0.0073***	0.0052*	-0.0008	0.0367***	0.0026*	-0.0012**	-0.0103	0.0098***	0.2074***	0.1556
-	-	(-0.57)	(2.72)	(1.77)	(-0.36)	(4.26)	(1.85)	(-2.40)	(-0.75)	(3.97)	(7.04)	

Panel B: Local Stock-Market Indexes

Sample correlation	*Implied correlation*	*Idio correlation*	*EBITDA/EV ratio*	*MV*	*ROE*	*EP*	*OP*	*INV*	*NSI*	*MOM*	*IVOL*	R^2
-0.0041	-	-	0.0381***	0.0003	0.0013	0.0480**	0.0033	-0.0031	0.0033	0.0142***	-0.0362	0.4501
(-1.19)	-	-	(3.10)	(0.86)	(0.09)	(2.03)	(0.37)	(-0.81)	(0.08)	(2.92)	(-0.78)	
-	-0.0033	-	0.0394***	0.0003	0.0017	0.0468**	0.0038	-0.0036	0.0072	0.0139***	-0.0318	0.4495
-	(-0.98)	-	(3.22)	(0.69)	(0.12)	(1.97)	(0.42)	(-0.92)	(0.17)	(2.84)	(-0.68)	
-	-	-0.0015	0.0441***	0.0002	-0.0022	0.0364	0.0050	-0.0038	0.0058	0.0122**	-0.0375	0.4332
-	-	(-0.08)	(3.49)	(0.41)	(-0.16)	(1.55)	(0.54)	(-0.99)	(0.14)	(2.44)	(-0.83)	

4.4.2. Results for Sub-Sample and Sub-Period Analyses

The results for each sub-sample and sub-period are obtained by re-conducting Fama-Macbeth regressions to examine the relationship between the correlation and index returns using new samples.

4.4.2.1. Results for Sub-Sample Analyses

The results of sub-sample analyses with developed vs emerging markets are presented in Table 4.4. Panel A of the table presents the results of developed markets for local industry indexes. Average coefficients on sample, implied and idiosyncratic correlations are insignificant with t-statistics of -1.07, -0.87 and 0.85, respectively. *EBITDA/EV*, *MV*, *EP*, *MOM* and *IVOL* are positively related to return for all regression specifications in developed markets for local industry indexes. Panel B of Table 4.4 presents the results of emerging markets for local industry indexes. Average coefficients of correlation are significantly different from zero at 5%, 10% and 1% significance levels with t-statistic as -2.57, -1.81 and -3.17 for the sample correlation, implied correlation and idiosyncratic correlation, respectively. Thus, the negative relation between correlation and returns is driven by the sample of emerging markets. *EBITDA/EV*, *EP*, *MOM* and *IVOL* are positively related to return for all regression specifications in emerging markets for local industry indexes. Panels C and D of Table 4.4 include the results of developed and emerging markets for local country indexes. Average coefficients on sample, implied and idiosyncratic correlations are insignificant with t-statistics of -1.33, -1.03 and 1.39 in developed markets. Similarly, t-statistics are also insignificant in emerging markets with the values of -0.31, -0.05 and -0.03. Overall, average coefficients on sample, implied and idiosyncratic correlations are statistically significant in emerging markets for local industry indexes. However, they are insignificant both in developed and emerging markets for local country indexes.

Table 4.4. Sub-Sample Analyses with Developed vs Emerging Markets

Sample corr.	*Implied corr.*	*Idio corr.*	*EBITDA/EV ratio*	*MV*	*ROE*	*EP*	*OP*	*INV*	*NSI*	*MOM*	*IVOL*	*R^2*
Panel A: Local Supersector Indexes (Developed Markets)												
-0.0035	-	-	0.0093***	0.0050*	-0.0003	0.0431***	0.0008	-0.0005	-0.0066	0.0139***	0.1194***	0.1944
(-1.07)	-	-	(3.17)	(1.89)	(-0.15)	(3.83)	(0.46)	(-0.61)	(-0.57)	(4.97)	(3.42)	
-	-0.0027	-	0.0094***	0.0047*	-0.0004	0.0428***	0.0010	-0.0005	-0.0063	0.0135***	0.1217***	0.1946
-	(-0.87)	-	(3.22)	(1.80)	(-0.16)	(3.80)	(0.57)	(-0.63)	(-0.54)	(4.78)	(3.52)	
-	-	0.0117	0.0094***	0.0047*	-0.0007	0.0455***	0.0005	-0.0001	-0.0020	0.0128***	0.1218***	0.1808
-	-	(0.85)	(3.15)	(1.65)	(-0.30)	(4.01)	(0.29)	(-0.18)	(-0.16)	(4.19)	(3.78)	
Panel B: Local Supersector Indexes (Emerging Markets)												
Sample corr.	*Implied corr.*	*Idio corr.*	*EBITDA/EV ratio*	*MV*	*ROE*	*EP*	*OP*	*INV*	*NSI*	*MOM*	*IVOL*	*R^2*
-0.0109**	-	-	0.0146**	-0.0468	0.0046	0.0383***	-0.0008	-0.0010	-0.0039	0.0106***	0.2052***	0.2332
(-2.57)	-	-	(2.24)	(-0.84)	(0.67)	(2.76)	(-0.22)	(-0.95)	(-0.11)	(3.11)	(6.55)	
-	-0.0075*	-	0.0144**	-0.0576	0.0040	0.0403***	-0.0005	-0.0009	-0.0035	0.0105***	0.2066***	0.2323
-	(-1.81)	-	(2.19)	(-1.01)	(0.58)	(2.91)	(-0.13)	(-0.91)	(-0.10)	(3.06)	(6.63)	
-	-	-0.0656***	0.0112*	-0.0555	0.0021	0.0352**	0.0001	-0.0010	0.0018	0.0103***	0.2138***	0.2251
-	-	(-3.17)	(1.83)	(-1.00)	(0.32)	(2.46)	(0.03)	(-0.96)	(0.05)	(2.95)	(6.90)	
Panel C: Local Stock-Market Indexes (Developed Markets)												
Sample corr.	*Implied corr.*	*Idio corr.*	*EBITDA/EV ratio*	*MV*	*ROE*	*EP*	*OP*	*INV*	*NSI*	*MOM*	*IVOL*	*R^2*
-0.0073	-	-	0.0390*	0.0004	0.0022	0.0502	-0.0060	-0.0023	0.1159	0.0136**	-0.1105	0.6045
(-1.33)	-	-	(1.80)	(0.84)	(0.15)	(1.25)	(-0.51)	(-0.47)	(1.23)	(2.05)	(-1.59)	
-	-0.0055	-	0.0382*	0.0002	0.0013	0.0488	-0.0031	-0.0023	0.1037	0.0121*	-0.1140*	0.6047
-	(-1.03)	-	(1.79)	(0.39)	(0.08)	(1.22)	(-0.26)	(-0.48)	(1.11)	(1.83)	(-1.70)	
-	-	0.0304	0.0414**	0.0009*	-0.0026	0.0738*	-0.0073	-0.0044	0.1320	0.0116*	-0.0748	0.5881
-	-	(1.39)	(1.99)	(1.82)	(-0.17)	(1.77)	(-0.59)	(-0.93)	(1.42)	(1.74)	(-1.28)	
Panel D: Local Stock-Market Indexes (Emerging Markets)												
Sample corr.	*Implied corr.*	*Idio corr.*	*EBITDA/EV ratio*	*MV*	*ROE*	*EP*	*OP*	*INV*	*NSI*	*MOM*	*IVOL*	*R^2*
-0.0014	-	-	0.0444*	0.0002	0.0117	0.0254	0.0011	-0.0091	0.0504	0.0100	-0.0198	0.5604
(-0.31)	-	-	(1.77)	(0.01)	(0.39)	(0.85)	(0.06)	(-1.45)	(0.61)	(1.42)	(-0.37)	
-	-0.0002	-	0.0363	-0.0032	0.0114	0.0217	0.0029	-0.0098	0.0405	0.0096	-0.0036	0.5591
-	(-0.05)	-	(1.49)	(-0.17)	(0.38)	(0.73)	(0.16)	(-1.56)	(0.49)	(1.37)	(-0.07)	
-	-	-0.0009	0.0497*	0.0076	0.0014	0.0126	0.0050	-0.0089	0.0294	0.0059	-0.0174	0.5496
-	-	(-0.03)	(1.94)	(0.37)	(0.05)	(0.41)	(0.26)	(-1.41)	(0.38)	(0.84)	(-0.32)	

Table 4.5 provides the results of sub-sample analyses according to market value. Panel A of Table 4.5 presents the results of big markets for local industry indexes. Average coefficients of sample correlation and implied correlation are significantly different from zero at 1% and 5% significance level with t-statistics of -2.62 and -2.10, respectively. So, there is a negative relationship between sample/implied correlation and future returns. The average coefficient of idiosyncratic correlation is insignificant with a t-statistic of 0.15 for local industry indexes in big markets. *EBITDA/EV*, *EP* and *MOM* are positively related to return in big markets. Panel B of Table 4.5 presents the results for small markets for local industry indexes. Average coefficients of sample correlation and implied correlation are significantly different from zero at a significance level of 5% with t-statistics of -2.31 and -2.14, respectively. However, the average coefficient of idiosyncratic correlation is insignificant with a t-statistic of -1.47. In sum, the results for big and small samples of local industry indexes do not differ from each other on qualitative terms and the obtained results for local industries are not sensitive to the size of indexes. Panel C and Panel D of Table 4.5 present the results of big and small sub-samples of local country indexes, respectively. Average coefficients on sample, implied, and idiosyncratic correlations are insignificant with t-statistics of -1.24, -0.61 and -0.71 in big markets, and with statistics of 1.16, 0.35, and -1.89 in small markets. Again, the results are very identical for big and small segments of local country indexes, and thus, the size of indexes does not change the lack of relation between correlation measures and returns for local country indexes. Overall, the size effect is a concern neither for industry nor for country indexes.

Table 4.5. Sub-Sample Analyses based on Market Value

Panel A: Local Supersector Indexes (Big Markets)

Sample corr.	*Implied corr.*	*Idio corr.*	*EBITDA/EV ratio*	*MV*	*ROE*	*EP*	*OP*	*INV*	*NSI*	*MOM*	*IVOL*	*R²*
-0.0087***	-	-	0.0133***	0.0025	0.0027	0.0355**	0.0003	-0.0005	-0.0126	0.0107***	0.0068	0.2030
(-2.62)	-	-	(3.59)	(1.03)	(0.74)	(2.56)	(0.12)	(-0.76)	(-0.68)	(3.29)	(0.22)	
-	-0.0068**	-	0.0136***	0.0025	0.0026	0.0363***	0.0005	-0.0006	-0.0135	0.0105***	0.0116	0.2029
-	(-2.10)	-	(3.65)	(1.02)	(0.70)	(2.62)	(0.20)	(-0.88)	(-0.72)	(3.22)	(0.37)	
-	-	0.0021	0.0130***	0.0016	0.0032	0.0357**	0.0003	-0.0005	-0.0119	0.0096***	0.0235	0.1887
-	-	(0.15)	(3.38)	(0.72)	(0.83)	(2.44)	(0.13)	(-0.79)	(-0.65)	(2.74)	(0.80)	

Panel B: Local Supersector Indexes (Small Markets)

Sample corr.	*Implied corr.*	*Idio corr.*	*EBITDA/EV ratio*	*MV*	*ROE*	*EP*	*OP*	*INV*	*NSI*	*MOM*	*IVOL*	*R²*
-0.0075**	-	-	0.0088***	0.1947	-0.0031	0.0361***	0.0024	-0.0004	-0.0114	0.0106***	0.2590***	0.1951
(-2.31)	-	-	(2.62)	(0.80)	(-1.20)	(3.92)	(1.38)	(-0.59)	(-0.70)	(4.39)	(7.93)	
-	-0.0068**	-	0.0088***	0.1861	-0.0031	0.0358***	0.0025	-0.0005	-0.0118	0.0105***	0.2593***	0.1946
-	(-2.14)	-	(2.59)	(0.75)	(-1.20)	(3.88)	(1.44)	(-0.61)	(-0.72)	(4.32)	(7.97)	
-	-	-0.0202	0.0085**	0.1536	-0.0028	0.0381***	0.0024	-0.0005	-0.0130	0.0099***	0.2627***	0.1879
-	-	(-1.47)	(2.46)	(0.58)	(-1.08)	(4.15)	(1.39)	(-0.64)	(-0.81)	(3.97)	(8.08)	

Panel C: Local Stock-Market Indexes (Big Markets)

Sample corr.	*Implied corr.*	*Idio corr.*	*EBITDA/EV ratio*	*MV*	*ROE*	*EP*	*OP*	*INV*	*NSI*	*MOM*	*IVOL*	*R²*
-0.0104	-	-	0.0722**	0.0001	-0.0050	0.0752	0.0086	0.0063	-0.1044	0.0114	-0.2233**	0.5933
(-1.24)	-	-	(2.03)	(0.05)	(-0.15)	(1.42)	(0.47)	(0.86)	(-0.55)	(1.16)	(-2.20)	
-	-0.0066	-	0.0496	0.0003	-0.0120	0.0459	0.0161	0.0096	-0.2875	0.0192	-0.2835	0.5945
-	(-0.61)	-	(1.04)	(0.19)	(-0.26)	(0.76)	(0.77)	(1.20)	(-1.09)	(1.38)	(-1.35)	
-	-	-0.0420	0.1144***	0.0013	0.0010	0.0984	-0.0242	-0.0054	0.0346	-0.0128	-0.0884	0.5856
-	-	(-0.71)	(2.59)	(1.22)	(0.02)	(1.29)	(-0.67)	(-0.51)	(0.10)	(-0.61)	(-0.71)	

Panel D: Local Stock-Market Indexes (Small Markets)

Sample corr.	*Implied corr.*	*Idio corr.*	*EBITDA/EV ratio*	*MV*	*ROE*	*EP*	*OP*	*INV*	*NSI*	*MOM*	*IVOL*	*R²*
0.0107	-	-	0.0061	0.0931	0.0104	-0.0920	0.0149	-0.0029	-0.1555	0.0019	0.0043	0.6353
(1.16)	-	-	(0.26)	(1.02)	(0.33)	(-1.03)	(0.63)	(-0.47)	(-0.84)	(0.18)	(0.06)	
-	0.0050	-	0.0066	0.1202	0.1281	-0.1493	-0.0488	-0.0036	-0.3452	-0.0118	0.0774	0.6352
-	(0.35)	-	(0.22)	(1.25)	(1.50)	(-1.54)	(-0.91)	(-0.59)	(-1.40)	(-0.39)	(0.53)	
-	-	-0.0780*	0.0313	0.0716	0.0005	-0.0112	-0.0039	-0.0053	-0.0447	0.0058	0.0123	0.6246
-	-	(-1.89)	(1.30)	(1.18)	(0.02)	(-0.22)	(-0.22)	(-0.86)	(-0.35)	(0.66)	(0.19)	

Table 4.6 presents the results for the analyses that make a distinction between segmented and integrated markets. Panels A and B of the table show the results of segmented and integrated indexes of the industry sub-sample, respectively. Panels C and D focus on the same sub-samples of country indexes. The results mainly indicate that the correlation effect is stronger in segmented markets of industry indexes whereas such an effect exists neither for segmented nor for integrated indexes of country sample.

Overall, the results for sub-sample analyses reveal that the negative relation between sample/implied correlations and future returns is stronger for emerging and segmented indexes of industry sample. However, correlation is not a predictor of country returns for both the full sample and sub-samples of country indexes. Thus, investing across industries rather than countries provides more profit opportunities.

Table 4.6. Sub-Sample Analyses with Segmented vs Integrated Markets

Sample corr.	*Implied corr.*	*Idio corr.*	*EBITDA/EV ratio*	*MV*	*ROE*	*EP*	*OP*	*INV*	*NSI*	*MOM*	*IVOL*	*R²*
Panel A: Local Supersector Indexes (Segmented Markets)												
-0.0077**	-	-	0.0055	0.0055	-0.0058*	0.0309***	0.0044**	-0.0005	-0.0050	0.0113***	0.1782***	0.2177
(-2.29)	-	-	(1.58)	(0.53)	(-1.85)	(3.68)	(2.01)	(-0.60)	(-0.23)	(4.40)	(5.84)	
-	-0.0060*	-	0.0055	0.0049	-0.0054*	0.0310***	0.0044**	-0.0006	-0.0065	0.0112***	0.1797***	0.2172
-	(-1.80)	-	(1.54)	(0.47)	(-1.74)	(3.69)	(2.03)	(-0.71)	(-0.31)	(4.32)	(5.92)	
-	-	-0.0169	0.0048	0.0029	-0.0054*	0.0338***	0.0042*	-0.0008	-0.0072	0.0105***	0.1891***	0.2060
-	-	(-1.16)	(1.31)	(0.25)	(-1.74)	(3.97)	(1.94)	(-0.88)	(-0.33)	(3.86)	(6.36)	
Panel B: Local Supersector Indexes (Integrated Markets)												
Sample corr.	*Implied corr.*	*Idio corr.*	*EBITDA/EV ratio*	*MV*	*ROE*	*EP*	*OP*	*INV*	*NSI*	*MOM*	*IVOL*	*R²*
-0.0049*	-	-	0.0130***	0.0061**	0.0076**	0.3506***	-0.0013	-0.0008	-0.0081	0.0111***	0.0890***	0.1691
(-1.76)	-	-	(3.58)	(2.18)	(2.33)	(14.52)	(-0.59)	(-1.42)	(-0.45)	(4.42)	(3.43)	
-	-0.0038	-	0.0132***	0.0055**	0.0074**	0.3493***	-0.0011	-0.0008	-0.0081	0.0108***	0.0899***	0.1685
-	(-1.40)	-	(3.65)	(1.98)	(2.29)	(14.43)	(-0.50)	(-1.38)	(-0.45)	(4.28)	(3.49)	
-	-	-0.0081	0.0123***	0.0055**	0.0072**	0.3495***	-0.0012	-0.0009*	-0.0013	0.0096***	0.0942***	0.1543
-	-	(-0.74)	(3.23)	(2.09)	(2.20)	(14.25)	(-0.55)	(-1.73)	(-0.08)	(3.61)	(3.85)	
Panel C: Local Stock-Market Indexes (Segmented Markets)												
Sample corr.	*Implied corr.*	*Idio corr.*	*EBITDA/EV ratio*	*MV*	*ROE*	*EP*	*OP*	*INV*	*NSI*	*MOM*	*IVOL*	*R²*
-0.0012	-	-	0.0634**	0.0128	-0.0079	0.0247	0.0100	-0.0073	-0.0841	0.0079	0.0063	0.6332
(-0.22)	-	-	(2.51)	(0.76)	(-0.36)	(0.57)	(0.70)	(-1.20)	(-0.59)	(1.11)	(0.10)	
-	0.0066	-	0.0640**	0.0127	-0.0059	0.0319	0.0102	-0.0109*	-0.0181	0.0035	0.0196	0.6324
-	(0.88)	-	(2.53)	(0.73)	(-0.27)	(0.57)	(0.69)	(-1.70)	(-0.12)	(0.47)	(0.29)	
-	-	-0.0221	0.0879***	0.0077	0.0102	-0.0265	0.0105	-0.0108*	-0.0337	-0.0025	0.0138	0.6214
-	-	(-0.42)	(3.40)	(0.46)	(0.50)	(-0.65)	(0.70)	(-1.73)	(-0.22)	(-0.35)	(0.22)	
Panel D: Local Stock-Market Indexes (Integrated Markets)												
Sample corr.	*Implied corr.*	*Idio corr.*	*EBITDA/EV ratio*	*MV*	*ROE*	*EP*	*OP*	*INV*	*NSI*	*MOM*	*IVOL*	*R²*
-0.0035	-	-	0.0255	-0.0003	0.0194	0.2247***	0.0058	-0.0045	0.0985	0.0111*	-0.0478	0.5277
(-0.86)	-	-	(0.98)	(-1.24)	(0.99)	(3.33)	(0.41)	(-0.80)	(1.33)	(1.78)	(-0.77)	
-	-0.0030	-	0.0276	-0.0002	0.0137	0.2258***	0.0100	-0.0052	0.1081	0.0100	-0.0475	0.5267
-	(-0.79)	-	(1.05)	(-0.89)	(0.70)	(3.39)	(0.73)	(-0.95)	(1.50)	(1.62)	(-0.77)	
-	-	0.0216	0.0403	-0.0001	0.0091	0.2261***	0.0142	-0.0040	0.1555**	0.0103	-0.0567	0.5100
-	-	(1.16)	(1.48)	(-0.26)	(0.46)	(3.72)	(1.01)	(-0.69)	(2.01)	(1.57)	(-0.96)	

4.4.2.2. Results for Sub-Period Analyses

Table 4.7 shows the results of sub-period analyses with bull vs bear markets. Panel A of Table 4.7 presents the results of bull markets for local industry indexes. Average coefficients of sample correlation and implied correlation are significantly different from zero with t-statistics of 3.23 and 3.43, respectively. Panel B of Table 4.7 includes the results of bear markets for local industry indexes. Average coefficients of sample correlation and implied correlation are also significantly different from zero at 1% significance level with t-statistics of -7.94 and -7.80, respectively. Average coefficients of idiosyncratic correlations are insignificant with t-statistics of -0.40 and 1.15 in these panels, respectively. The variables having explanatory power on returns differ for both bull and bear markets, except for *MOM* and *IVOL*. *EP* and *INV* have explanatory power on return for bull markets whereas *EBITDA/EV*, *MV* and *OP* have explanatory power on return for bear markets for local industry indexes. On the other hand, Panel C and Panel D of Table 4.7 indicate the results of bull and bear markets for local country indexes. Average coefficients of sample correlation and implied correlation for local country indexes are significantly different from zero at 5% significance level with t-statistics of 2.06 and 1.99 in bull markets, respectively. Average coefficients of sample correlation and implied correlation for local country indexes are significantly different from zero at 1% significance level with t-statistics of -6.80 and -6.93 in bear markets, respectively. Average coefficients of idiosyncratic correlations are insignificant with t-statistics of -0.60 and 1.63 in Panel C and Panel D, respectively. The variables having explanatory power on return differ for both bull and bear markets across local country indexes, except for *IVOL*. Overall, average coefficients of sample correlation and implied correlation are statistically significant in bull and bear markets for both local industry and local country indexes. For both indexes, returns have a negative relationship with sample/implied correlation for bear markets. Supportively, returns have a positive relation with sample/implied correlation for bull markets. The explanatory power of sample and implied correlations on the return are not significantly affected by the alternating forces of bull and bear markets as the results in the study of Fabozzi and Francis (1977). However, the explanatory power and statistical significance of correlations for local industry indexes are higher than those of local country indexes both in bull and bear markets.

Table 4.7. Sub-Period Analyses with Bull vs Bear Markets

Panel A: Local Supersector Indexes (Bull Markets)												
Sample corr.	*Implied corr.*	*Idio corr.*	*EBITDA/EV ratio*	*MV*	*ROE*	*EP*	*OP*	*INV*	*NSI*	*MOM*	*IVOL*	*R²*
0.0111***	-	-	0.0038	0.0000	-0.0030	0.0395***	0.0020	-0.0025***	-0.0176	0.0070*	0.3626***	0.1621
(3.23)	-	-	(0.89)	(0.01)	(-0.81)	(2.83)	(0.78)	(-3.06)	(-0.65)	(1.81)	(6.86)	
-	0.0117***	-	0.0041	-0.0006	-0.0031	0.0391***	0.0022	-0.0025***	-0.0143	0.0067*	0.3594***	0.1623
-	(3.43)	-	(0.94)	(-0.16)	(-0.82)	(2.80)	(0.86)	(-3.07)	(-0.54)	(1.72)	(6.82)	
-	-	-0.0063	0.0026	0.0054	-0.0030	0.0412***	0.0020	-0.0027***	-0.0118	0.0053	0.3457***	0.1579
-	-	(-0.40)	(0.60)	(1.39)	(-0.79)	(2.93)	(0.80)	(-3.16)	(-0.46)	(1.28)	(6.61)	
Panel B: Local Supersector Indexes (Bear Markets)												
Sample corr.	*Implied corr.*	*Idio corr.*	*EBITDA/EV ratio*	*MV*	*ROE*	*EP*	*OP*	*INV*	*NSI*	*MOM*	*IVOL*	*R²*
-0.0550***	-	-	0.0155**	0.0148*	-0.0084	0.0190	0.0071**	-0.0001	0.0157	0.0165***	-0.1069*	0.1671
(-7.94)	-	-	(2.37)	(1.71)	(-1.40)	(0.89)	(2.21)	(-0.10)	(0.75)	(2.96)	(-1.77)	
-	-0.0536***	-	0.0154**	0.0169**	-0.0084	0.0196	0.0075**	-0.0002	0.0140	0.0164***	-0.1036*	0.1667
-	(-7.80)	-	(2.39)	(1.97)	(-1.40)	(0.93)	(2.29)	(-0.16)	(0.66)	(2.96)	(-1.70)	
-	-	0.0460	0.0149**	-0.0049	-0.0076	0.0294	0.0057*	-0.0003	0.0131	0.0175***	-0.0557	0.1396
-	-	(1.15)	(2.34)	(-0.56)	(-1.34)	(1.41)	(1.91)	(-0.22)	(0.61)	(2.96)	(-0.95)	
Panel C: Local Stock-Market Indexes (Bull Markets)												
Sample corr.	*Implied corr.*	*Idio corr.*	*EBITDA/EV ratio*	*MV*	*ROE*	*EP*	*OP*	*INV*	*NSI*	*MOM*	*IVOL*	*R²*
0.0079**	-	-	0.0563***	-0.0003	-0.0325*	0.0580	0.0199*	-0.0116*	-0.0909	0.0096	0.1520**	0.4369
(2.06)	-	-	(2.87)	(-0.55)	(-1.78)	(1.58)	(1.67)	(-1.87)	(-1.60)	(1.22)	(2.13)	
-	0.0075**	-	0.0578***	-0.0003	-0.0341*	0.0577	0.0194	-0.0118*	-0.0938*	0.0093	0.1512**	0.4360
-	(1.99)	-	(2.97)	(-0.62)	(-1.89)	(1.58)	(1.62)	(-1.89)	(-1.69)	(1.20)	(2.12)	
-	-	-0.0108	0.0575***	0.0001	-0.0313*	0.0439	0.0214*	-0.0138**	-0.0909*	0.0036	0.1228*	0.4307
-	-	(-0.60)	(3.04)	(0.23)	(-1.70)	(1.18)	(1.68)	(-2.22)	(-1.66)	(0.46)	(1.79)	
Panel D: Local Stock-Market Indexes (Bear Markets)												
Sample corr.	*Implied corr.*	*Idio corr.*	*EBITDA/EV ratio*	*MV*	*ROE*	*EP*	*OP*	*INV*	*NSI*	*MOM*	*IVOL*	*R²*
-0.0524***	-	-	-0.0354	0.0026*	-0.0252	0.1082	0.0030	0.0012	0.0818	0.0282**	-0.5207***	0.4699
(-6.80)	-	-	(-1.40)	(1.91)	(-0.67)	(1.53)	(0.12)	(0.14)	(0.65)	(2.21)	(-6.49)	
-	-0.0522***	-	-0.0334	0.0030**	-0.0252	0.1140	0.0063	-0.0003	0.0903	0.0272**	-0.5259***	0.4701
-	(-6.93)	-	(-1.34)	(2.18)	(-0.67)	(1.62)	(0.24)	(-0.03)	(0.71)	(2.11)	(-6.42)	
-	-	0.0856	-0.0061	0.0007	-0.0385	0.1161*	-0.0027	0.0062	0.0425	0.0284**	-0.4859***	0.4302
-	-	(1.63)	(-0.23)	(0.64)	(-0.98)	(1.83)	(-0.10)	(0.75)	(0.34)	(2.18)	(-5.53)	

Table 4.8 provides the results of sub-period analyses with markets based on high vs low volatility. Panel A of Table 4.8 presents the results of markets with high volatility for local industry indexes. Average coefficients of sample correlation and implied correlation are significantly different from zero at 10% and 5% significance level with t-statistics of -1.78 and -1.98, respectively. The average coefficient of idiosyncratic correlation is insignificant with a t-statistic of 0.56 for local industry indexes in markets with high volatility. *EBITDA/EV*, *MV*, *ROE*, *EP*, *MOM* and *IVOL* are positively related to returns in markets with high volatility. Panel B of Table 4.8 indicates the results of markets with low volatility for local industry indexes. Average coefficients on sample, implied and idiosyncratic correlations are insignificant with t-statistics of 0.32, 1.50 and -1.06 in markets with low volatility, respectively. On the other hand, Panel C and Panel D of Table 4.8 reports the results of markets with high and low volatility for local country indexes. Average coefficients on sample, implied and idiosyncratic correlations are insignificant with t-statistics of -0.66, -0.92 and 0.65 in markets with high volatility and insignificant with t-statistics of -0.99, -0.43 and -0.25 in markets with low volatility, respectively. Overall, average coefficients of sample correlation and implied correlation are statistically significant just in markets with high volatility for local industry indexes. Besides, there is a negative (positive) relationship between correlation and return for a market with high (low) volatility for local industry indexes. However, the average coefficients on sample, implied and idiosyncratic correlations are insignificant both in markets with high and low volatility for local country indexes.

Table 4.8. Sub-Period Analyses with Markets based on High vs Low Volatility

Panel A: Local Supersector Indexes (High Volatility)												
Sample corr.	*Implied corr.*	*Idio corr.*	*EBITDA/EV ratio*	*MV*	*ROE*	*EP*	*OP*	*INV*	*NSI*	*MOM*	*IVOL*	R^2
-0.0112^{*}	-	-	0.0057^{**}	0.0099^{**}	0.0059^{**}	0.0212^{*}	0.0012	-0.0005	-0.0219	0.0076^{*}	0.0829^{**}	0.1749
(-1.78)	-	-	(2.38)	(2.04)	(2.30)	(1.69)	(0.74)	(-0.90)	(-1.38)	(1.78)	(2.07)	
-	-0.0120^{**}	-	0.0058^{**}	0.0103^{**}	0.0059^{**}	0.0214^{*}	0.0014	-0.0005	-0.0225	0.0073^{*}	0.0826^{**}	0.1734
-	(-1.98)	-	(2.43)	(2.11)	(2.28)	(1.69)	(0.85)	(-0.91)	(-1.42)	(1.67)	(2.07)	
-	-	0.0145	0.0064^{***}	0.0081^{*}	0.0055^{**}	0.0239^{*}	0.0007	-0.0005	-0.0201	0.0056	0.0934^{**}	0.1509
-	-	(0.56)	(2.73)	(1.71)	(2.10)	(1.93)	(0.46)	(-0.82)	(-1.24)	(1.11)	(2.50)	
Panel B: Local Supersector Indexes (Low Volatility)												
Sample corr.	*Implied corr.*	*Idio corr.*	*EBITDA/EV ratio*	*MV*	*ROE*	*EP*	*OP*	*INV*	*NSI*	*MOM*	*IVOL*	R^2
0.0011	-	-	0.0038	0.0056	-0.0039	0.0523^{***}	0.0028	-0.0012	-0.0250	0.0110^{***}	0.2652^{***}	0.1610
(0.32)	-	-	(0.67)	(1.31)	(-1.02)	(3.60)	(1.23)	(-1.14)	(-0.85)	(3.96)	(5.11)	
-	0.0051	-	0.0036	0.0045	-0.0039	0.0517^{***}	0.0030	-0.0012	-0.0238	0.0111^{***}	0.2682^{***}	0.1611
-	(1.50)	-	(0.62)	(1.04)	(-1.01)	(3.54)	(1.31)	(-1.17)	(-0.82)	(3.98)	(5.21)	
-	-	-0.0118	0.0022	0.0057	-0.0031	0.0506^{***}	0.0030	-0.0014	-0.0219	0.0109^{***}	0.2662^{***}	0.1572
-	-	(-1.06)	(0.38)	(1.26)	(-0.80)	(3.45)	(1.35)	(-1.34)	(-0.76)	(4.02)	(5.21)	
Panel C: Local Stock-Market Indexes (High Volatility)												
Sample corr.	*Implied corr.*	*Idio corr.*	*EBITDA/EV ratio*	*MV*	*ROE*	*EP*	*OP*	*INV*	*NSI*	*MOM*	*IVOL*	R^2
-0.0046	-	-	0.0147	0.0009	0.0084	0.0606^{*}	0.0065	-0.0049	0.0418	0.0092	-0.1375^{**}	0.4372
(-0.66)	-	-	(0.91)	(1.37)	(0.44)	(1.66)	(0.51)	(-1.05)	(0.60)	(1.27)	(-1.96)	
-	-0.0061	-	0.0141	0.0009	0.0094	0.0580	0.0078	-0.0059	0.0455	0.0082	-0.1390^{*}	0.4360
-	(-0.92)	-	(0.88)	(1.35)	(0.50)	(1.60)	(0.61)	(-1.23)	(0.65)	(1.12)	(-1.95)	
-	-	0.0281	0.0238	0.0014^{**}	0.0002	0.0541	0.0057	-0.0034	0.0671	0.0050	-0.1562^{**}	0.4089
-	-	(0.65)	(1.32)	(1.96)	(0.01)	(1.50)	(0.43)	(-0.69)	(1.01)	(0.62)	(-2.30)	
Panel D: Local Stock-Market Indexes (Low Volatility)												
Sample corr.	*Implied corr.*	*Idio corr.*	*EBITDA/EV ratio*	*MV*	*ROE*	*EP*	*OP*	*INV*	*NSI*	*MOM*	*IVOL*	R^2
-0.0040	-	-	0.0674^{***}	0.0001	-0.0224	0.0133	0.0011	-0.0039	-0.0434	0.0151^{*}	-0.0592	0.4583
(-0.99)	-	-	(3.75)	(0.15)	(-0.92)	(0.33)	(0.07)	(-0.54)	(-0.76)	(1.85)	(-0.76)	
-	-0.0018	-	0.0702^{***}	0.0000	-0.0222	0.0122	0.0008	-0.0036	-0.0394	0.0152^{*}	-0.0500	0.4581
-	(-0.43)	-	(3.99)	(0.06)	(-0.91)	(0.30)	(0.05)	(-0.50)	(-0.70)	(1.87)	(-0.64)	
-	-	-0.0031	0.0666^{***}	-0.0005	-0.0242	-0.0004	0.0090	-0.0059	-0.0421	0.0147^{*}	-0.0456	0.4478
-	-	(-0.25)	(3.63)	(-0.76)	(-1.01)	(-0.01)	(0.57)	(-0.80)	(-0.75)	(1.87)	(-0.61)	

Table 4.9 presents the results of sub-period analyses with markets based on recessionary vs expansionary period. Panel A of Table 4.9 indicates the results of markets based on the recessionary period for local industry indexes. Average coefficients on sample, implied and idiosyncratic correlations are insignificant with t-statistics of -0.52, -0.58 and 0.22, respectively. *EBITDA/EV* is just related to return in markets with the recessionary period. Panel B of Table 4.9 shows the results of markets based on the expansionary period for local industry indexes. The average coefficient of sample correlation is significantly different from zero at 10% significance level with a t-statistic of -1.72. *EBITDA/EV*, *MV*, *EP*, *OP*, *INV*, *MOM* and *IVOL* are related to return for the first regression specifications in Panel B. Panel C and Panel D of Table 4.9 show the results of markets based on the recessionary and expansionary period for local country indexes. Average coefficients on sample, implied and idiosyncratic correlations are insignificant with t-statistics of 0.39, 0.32 and 1.20 in markets based on recessionary period and insignificant with t-statistics of -1.46, -1.15 and -0.26 in markets based on expansionary period, respectively. Overall, the average coefficient of sample correlation is statistically significant just in markets based on the expansionary period for local industry indexes. However, the average coefficients on sample, implied and idiosyncratic correlations are insignificant both in markets based on the recessionary and expansionary periods for local country indexes.

Table 4.9. Sub-Period Analyses with Markets based on Recessionary vs Expansionary Period

Panel A: Local Supersector Indexes (Recessionary Period)												
Sample corr.	*Implied corr.*	*Idio corr.*	*EBITDA/EV ratio*	*MV*	*ROE*	*EP*	*OP*	*INV*	*NSI*	*MOM*	*IVOL*	*R^2*
-0.0092	-	-	0.0143**	0.0211	0.0027	0.0424	-0.0028	-0.0009	-0.0140	-0.0116	0.0479	0.1867
(-0.52)	-	-	(2.06)	(1.60)	(0.43)	(1.23)	(-0.71)	(-1.31)	(-0.39)	(-0.92)	(0.50)	
-	-0.0099	-	0.0144**	0.0214	0.0027	0.0429	-0.0023	-0.0010	-0.0149	-0.0127	0.0463	0.1856
-	(-0.58)	-	(2.07)	(1.62)	(0.43)	(1.24)	(-0.56)	(-1.45)	(-0.41)	(-0.96)	(0.48)	
-	-	0.0103	0.0169**	0.0242*	0.0016	0.0518	-0.0036	-0.0009	-0.0054	-0.0179	0.0482	0.1484
-	-	(0.22)	(2.50)	(1.95)	(0.23)	(1.56)	(-0.92)	(-1.28)	(-0.14)	(-1.12)	(0.57)	
Panel B: Local Supersector Indexes (Expansionary Period)												
Sample corr.	*Implied corr.*	*Idio corr.*	*EBITDA/EV ratio*	*MV*	*ROE*	*EP*	*OP*	*INV*	*NSI*	*MOM*	*IVOL*	*R^2*
-0.0050*	-	-	0.0069**	0.0055**	-0.0009	0.0330***	0.0034**	-0.0012**	-0.0115	0.0125***	0.2119***	0.1637
(-1.72)	-	-	(2.42)	(1.97)	(-0.40)	(3.70)	(2.27)	(-2.22)	(-0.76)	(5.94)	(6.67)	
-	-0.0032	-	0.0069**	0.0051*	-0.0009	0.0330***	0.0035**	-0.0012**	-0.0107	0.0124***	0.2135***	0.1630
-	(-1.14)	-	(2.38)	(1.82)	(-0.37)	(3.69)	(2.33)	(-2.25)	(-0.71)	(5.92)	(6.76)	
-	-	-0.0073	0.0066**	0.0035	-0.0009	0.0347***	0.0034**	-0.0013**	-0.0094	0.0119***	0.2170***	0.1545
-	-	(-0.56)	(2.26)	(1.16)	(-0.41)	(3.85)	(2.30)	(-2.35)	(-0.64)	(5.58)	(6.93)	
Panel C: Local Stock-Market Indexes (Recessionary Period)												
Sample corr.	*Implied corr.*	*Idio corr.*	*EBITDA/EV ratio*	*MV*	*ROE*	*EP*	*OP*	*INV*	*NSI*	*MOM*	*IVOL*	*R^2*
0.0080	-	-	-0.0270	0.0023	0.0088	0.1365	0.0158	0.0016	0.1792	-0.0112	-0.1036	0.4961
(0.39)	-	-	(-0.78)	(1.32)	(0.16)	(1.41)	(0.46)	(0.21)	(1.11)	(-0.60)	(-0.64)	
-	0.0063	-	-0.0279	0.0022	0.0059	0.1318	0.0177	0.0008	0.2067	-0.0150	-0.0928	0.4930
-	(0.32)	-	(-0.81)	(1.29)	(0.11)	(1.37)	(0.52)	(0.10)	(1.33)	(-0.79)	(-0.56)	
-	-	0.0704	-0.0231	0.0035**	-0.0076	0.1828**	0.0194	0.0019	0.2120	-0.0255	-0.1534	0.4454
-	-	(1.20)	(-0.55)	(2.09)	(-0.13)	(1.98)	(0.59)	(0.24)	(1.45)	(-1.13)	(-1.02)	
Panel D: Local Stock-Market Indexes (Expansionary Period)												
Sample corr.	*Implied corr.*	*Idio corr.*	*EBITDA/EV ratio*	*MV*	*ROE*	*EP*	*OP*	*INV*	*NSI*	*MOM*	*IVOL*	*R^2*
-0.0046	-	-	0.0438***	0.0002	0.0002	0.0390	0.0029	-0.0040	-0.0218	0.0161***	-0.0269	0.4444
(-1.46)	-	-	(3.32)	(0.43)	(0.02)	(1.59)	(0.31)	(-0.94)	(-0.49)	(3.18)	(-0.54)	
-	-0.0036	-	0.0455***	0.0001	0.0008	0.0379	0.0032	-0.0044	-0.0210	0.0161***	-0.0220	0.4441
-	(-1.15)	-	(3.47)	(0.29)	(0.05)	(1.54)	(0.34)	(-1.04)	(-0.48)	(3.18)	(-0.44)	
-	-	-0.0056	0.0497***	-0.0001	-0.0020	0.0234	0.0044	-0.0048	-0.0154	0.0150***	-0.0259	0.4321
-	-	(-0.26)	(3.72)	(-0.25)	(-0.14)	(0.95)	(0.46)	(-1.15)	(-0.36)	(2.98)	(-0.54)	

4.5. Conclusion

This chapter investigates the relationship between correlation and return by testing the forecasting power of average correlations for local industry and local country indexes. It also examines portfolio diversification strategies for asset allocation.

After three kinds of average correlations are estimated, they are used as inputs in Fama-MacBeth regression analyses with control variables for the research period. The analyses are also performed for sub-samples and sub-periods as alternative samples across both local industry and local country indexes.

This chapter demonstrates that average slopes on correlations for local industries are negatively significant whereas average slopes on correlations of local countries are insignificant. In other words, that average correlations of local industries predict future index returns. The results of the full sample are also supported based on local country indexes when the sub-sample and sub-period analyses are conducted in the sense that there is no relation between country returns and correlations. Therefore, it is concluded that diversification through local industries is more efficient than diversification through local countries. These findings have important and up-to-date implications for international investors and portfolio managers.

CHAPTER 5
CONCLUSION

Correlations are statistical measures that can identify diversification opportunities and predict returns in financial markets. The correlation structure of assets helps international investors maximize the effectiveness of their portfolio diversification. Correlations are also used to measure the degree of integration/segmentation of markets. Only global (local) factors affect returns if markets are perfectly integrated (segmented). Market integration/segmentation patterns may vary under several volatility conditions. Markets are not integrated or segmented in a fixed pattern as conditions change dynamically over time.

The fundamental determinants of correlations across indexes also determine the factors underlying the correlation structure. Moreover, correlations themselves are a substantial factor in forming a portfolio. Less correlation between the two assets provides more diversification benefits through portfolio management. International diversification can be attained through investing in local industry or country indexes and which diversification strategy is more beneficial for global investors is a natural research question.

This study addresses several main research questions. Firstly, it determines whether international diversification is still beneficial by analyzing the trends of average correlation series across local industries or local countries over time. If average correlations do not significantly increase over time, international diversification can still be applied. Secondly, if international diversification still has benefits, the study investigates whether more efficient diversification or risk reduction benefits can be obtained through local industries or countries, which is an ongoing debate in the literature. Third, having determined whether it is better to diversify through local industries or local countries, the study compares diversification options in developed and emerging markets and examines the relationship between correlation and return. Finally, it compares how well average correlations through local industry and local country indexes can predict future returns. The answers to these questions will have implications for the diversification strategies of international investors and portfolio managers.

Chapters Three and Four both consider correlations but in relation to different questions. Chapter Three analyzes the trend of average correlations over time and their diversification benefits using several different models to determine whether international diversification can avoid risk. The findings show that average correlations fluctuate and do not increase over time. Thus, international diversification still has benefits despite globalization. Moreover, the different correlation measures show that local industries always have lower correlations than local countries. This suggests that international diversification through local industry indexes provides more benefits to investors than relying on local country indexes. Finally, the findings generally demonstrate that diversifying across indexes from emerging markets has higher risk-reduction benefits than indexes from developed markets.

Chapter Four evaluates the relationship between returns and correlations from the perspective of asset pricing theory by examining whether correlation estimates can predict future index returns. More specifically, the average slope coefficients on correlation measures of industries are significantly different from zero whereas those of countries do not deviate from zero. Sub-sample analyses show that the relationship between correlation and future industry returns is stronger for industry indexes from emerging and segmented markets. Moreover, this relationship is more pronounced in high-volatility markets and bear markets.

This study's methodology and results contribute to the literature in several ways. Firstly, it is unique because it derives implied correlations using a multi-factor model, namely the FF3F model (Chapter Four). Using only a multi-factor model proves that the derivation of implied correlations from sample correlations is significant. Sample correlation results are consistent with implied correlation results of the FF3F model. Hence, idiosyncratic correlation from the FF3F model is also estimated as part of sample correlation. An implied correlation from a single-factor model, CAPM, is statistically equal to a sample correlation. This equality only holds for CAPM, not multi-factor models. The beta is already calculated from the sample covariance and already predicts implied correlations. Therefore, in a single-factor model, sample correlation and implied correlation are not statistically different. Even if the results of implied correlations are significant, the derivation of implied correlation from a single-factor model is redundant. Instead, implied correlations should be derived from a multi-factor model in terms of the decomposition of sample correlation. The Methodology section of Chapter Four proves this empirically in detail. The second contribution of this study is that it analyzes the relationship between correlation and return across both local industry and local country indexes (Chapter Four). Unlike the literature, these analyses are performed both at the industry and country levels through several models. Thirdly, the study provides direct evidence for the main claim, based on MPT, regarding how to construct a portfolio for international investors, specifically that a portfolio should include low correlated assets for maximum return and minimum risk. Average correlation estimates of industry indexes are statistically lower than those of country indexes over the research period. Thus, portfolio diversification through local industry indexes can increase returns for international investors. Diversification through local industries provides more benefits than through local countries. This is because average measures of correlations for local industry indexes are substantially lower than those of country indexes and have significant forecasting power for returns whereas average measures of correlations for local country indexes are lower and they have no predictive ability. Finally, the results for the sub-samples and sub-periods provide more insights. These further analyses show in which sub-samples the relation between correlation and industry returns is more significant. For local countries, these further analyses consistently support the results of the full sample and verify there is no relationship between correlation and future country returns. These results have important implications for international investors and portfolio managers for optimal construction of international investment portfolios in terms of strategic asset allocation.

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APPENDIX A

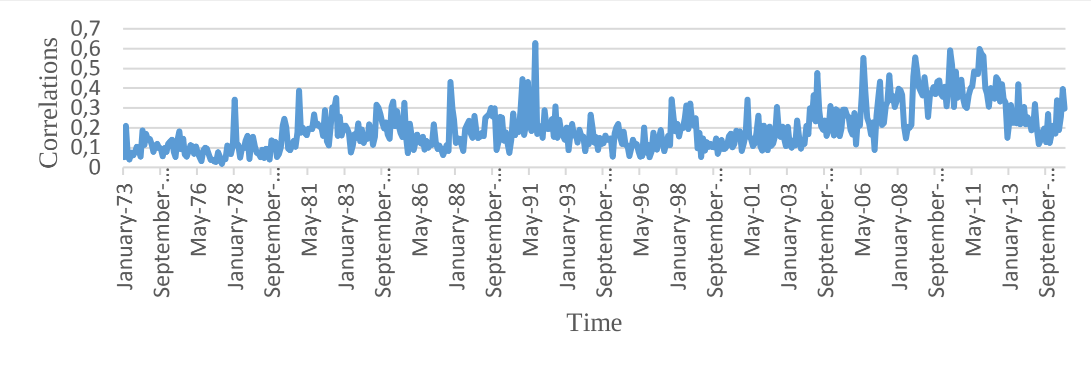

Figure A.1. Average Pair-wise Correlations for Local Industry Indexes

Table A.1. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for Pair-wise Correlations of Local Industry Indexes

Variable	Coefficient	t-Statistic	Prob.
MEANINDCOR(-1)	-0.014854	-0.968266	0.3334
D(MEANINDCOR(-1))	-0.556244	-12.060240	0.0000
D(MEANINDCOR(-2))	-0.442387	-8.601018	0.0000
D(MEANINDCOR(-3))	-0.331625	-6.151230	0.0000
D(MEANINDCOR(-4))	-0.240420	-4.488686	0.0000
D(MEANINDCOR(-5))	-0.217255	-4.292639	0.0000
D(MEANINDCOR(-6))	-0.153514	-3.443919	0.0006
The ADF Test Statistic		-0.968266	0.2976

Table A.2. Unit Root Test Statistics based on the Model with a Constant Term for Pair-wise Correlations of Local Industry Indexes

Variable	Coefficient	t-Statistic	Prob.
MEANINDCOR(-1)	-0.150943	-4.393399	0.0000
D(MEANINDCOR(-1))	-0.405205	-8.182500	0.0000
D(MEANINDCOR(-2))	-0.276704	-5.622274	0.0000
D(MEANINDCOR(-3))	-0.140199	-3.175372	0.0016
The ADF Test Statistic		-4.393399	0.0003

Table A.3. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for Correlations of Local Industry Indexes against Global Market Return

Variable	Coefficient	t-Statistic	Prob.
AGAINST_GLOBAL(-1)	-0.008838	-0.736689	0.4617
D(AGAINST_GLOBAL(-1))	-0.588907	-13.044190	0.0000
D(AGAINST_GLOBAL(-2))	-0.489544	-9.527978	0.0000
D(AGAINST_GLOBAL(-3))	-0.375076	-7.076071	0.0000
D(AGAINST_GLOBAL(-4))	-0.200809	-3.945797	0.0001
D(AGAINST_GLOBAL(-5))	-0.181812	-4.129880	0.0000
The ADF Test Statistic		-0.736689	0.3971

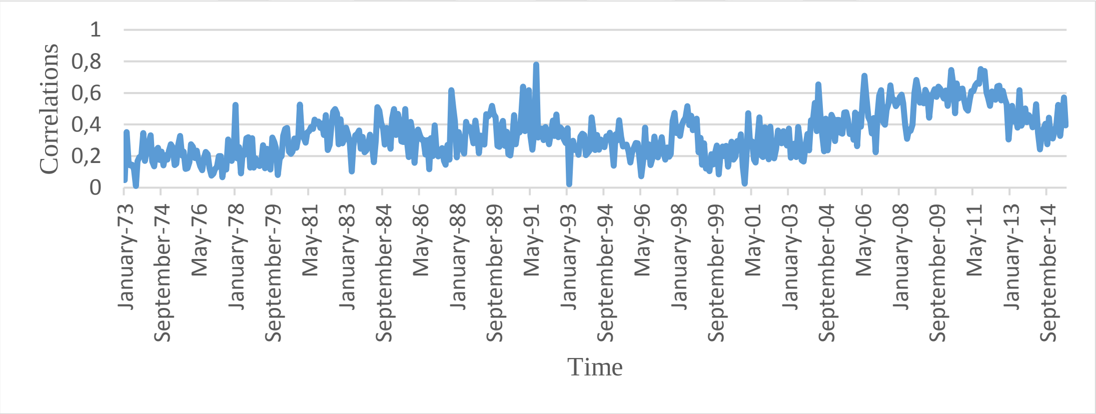

Figure A.2. Average Correlations against Global Market Return for Local Industry Indexes

Table A.4. Unit Root Test Statistics based on the Model with a Constant Term for Correlations of Local Industry Indexes against Global Market Return

Variable	Coefficient	t-Statistic	Prob.
AGAINST_GLOBAL(-1)	-0.112436	-3.236069	0.0013
D(AGAINST_GLOBAL(-1))	-0.507744	-9.852018	0.0000
D(AGAINST_GLOBAL(-2))	-0.423456	-7.697303	0.0000
D(AGAINST_GLOBAL(-3))	-0.324948	-5.923790	0.0000
D(AGAINST_GLOBAL(-4))	-0.165772	-3.210769	0.0014
D(AGAINST_GLOBAL(-5))	-0.161668	-3.666931	0.0003
The ADF Test Statistic		-3.236069	0.0186

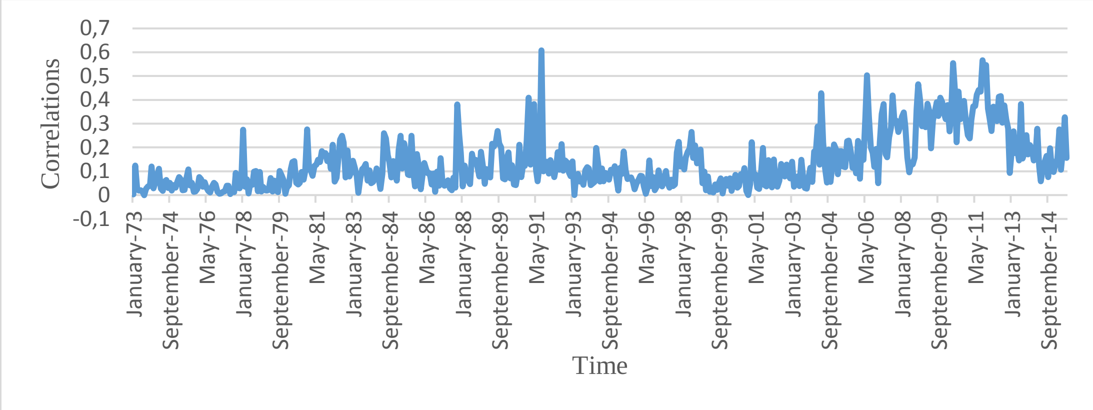

Figure A.3. Single-Factor Model Implied Correlations for Local Industry Indexes

Table A.5. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for Single-Factor ModelImplied Correlations of Local Industry Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IMPLIED(-1)	-0.027809	-1.408080	0.1597
D(MEAN_IMPLIED(-1))	-0.558426	-11.795570	0.0000
D(MEAN_IMPLIED(-2))	-0.463386	-8.868162	0.0000
D(MEAN_IMPLIED(-3))	-0.362758	-6.571716	0.0000
D(MEAN_IMPLIED(-4))	-0.207386	-3.793479	0.0002
D(MEAN_IMPLIED(-5))	-0.231457	-4.541451	0.0000
D(MEAN_IMPLIED(-6))	-0.139368	-3.109788	0.0020
The ADF Test Statistic		-1.408080	0.1482

Table A.6. Unit Root Test Statistics based on the Model with a Constant Term for Single-Factor Model Implied Correlations of Local Industry Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IMPLIED(-1)	-0.134706	-4.047023	0.0001
D(MEAN_IMPLIED(-1))	-0.436220	-8.903679	0.0000
D(MEAN_IMPLIED(-2))	-0.323541	-6.637637	0.0000
D(MEAN_IMPLIED(-3))	-0.190012	-4.321990	0.0000
The ADF Test Statistic		-4.047023	0.0013

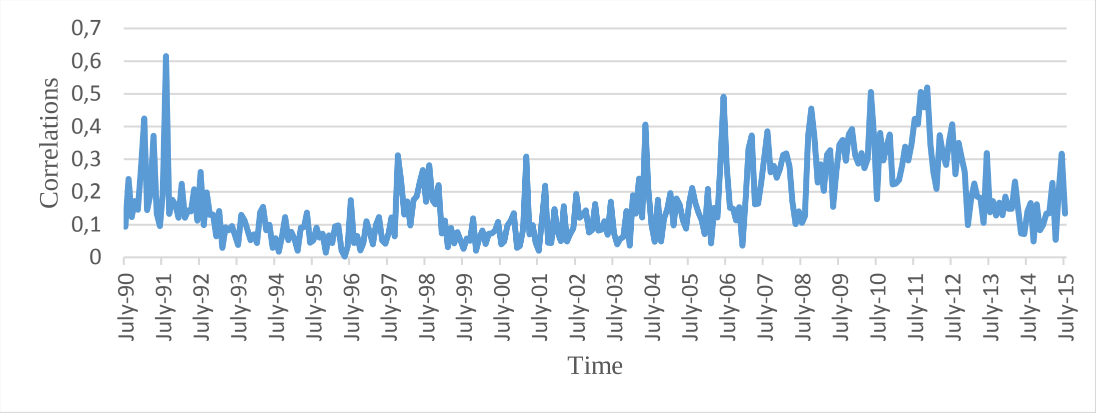

Figure A.4. Average FF3F Model Implied Correlations for Local Industry Indexes

Table A.7. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for FF3F Model Implied Correlations of Local Industry Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IMPLIED(-1)	-0.042484	-1.671932	0.0956
D(MEAN_IMPLIED(-1))	-0.524723	-8.831425	0.0000
D(MEAN_IMPLIED(-2))	-0.383207	-6.145632	0.0000
D(MEAN_IMPLIED(-3))	-0.235785	-4.121017	0.0000
The ADF Test Statistic		-1.671932	0.0894

Table A.8. Unit Root Test Statistics based on the Model with a Constant Term for FF3F Model Implied Correlations of Local Industry Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IMPLIED(-1)	-0.174989	-3.469421	0.0006
D(MEAN_IMPLIED(-1))	-0.430140	-6.476779	0.0000
D(MEAN_IMPLIED(-2))	-0.316621	-4.847367	0.0000
D(MEAN_IMPLIED(-3))	-0.198178	-3.429535	0.0007
The ADF Test Statistic		-3.469421	0.0095

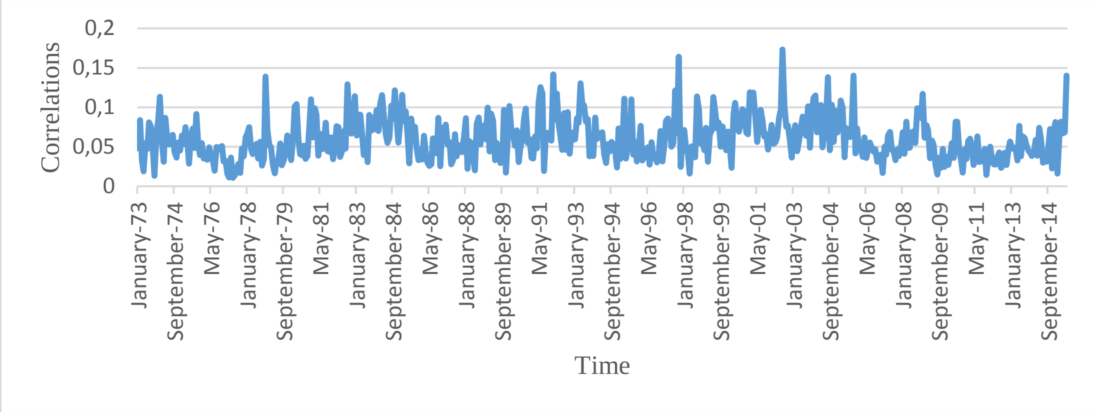

Figure A.5. Average Idiosyncratic Correlations from a Single-Factor Model for Local Industry Indexes

Table A.9. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for Idiosyncratic Correlations from a Single-Factor Model for Local Industry Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IDIO(-1)	-0.020811	-1.169960	0.2426
D(MEAN_IDIO(-1))	-0.670864	-14.223290	0.0000
D(MEAN_IDIO(-2))	-0.473535	-8.710687	0.0000
D(MEAN_IDIO(-3))	-0.345916	-6.113688	0.0000
D(MEAN_IDIO(-4))	-0.282925	-5.029431	0.0000
D(MEAN_IDIO(-5))	-0.284175	-5.340935	0.0000
D(MEAN_IDIO(-6))	-0.114205	-2.542790	0.0113
The ADF Test Statistic		-1.169960	0.2212

Table A.10. Unit Root Test Statistics based on the Model with a Constant Term for Idiosyncratic Correlations from a Single-Factor Model of Local Industry Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IDIO(-1)	-0.455371	-8.320629	0.0000
D(MEAN_IDIO(-1))	-0.274313	-5.075403	0.0000
D(MEAN_IDIO(-2))	-0.115257	-2.587612	0.0099
The ADF Test Statistic		-8.320629	0.0000

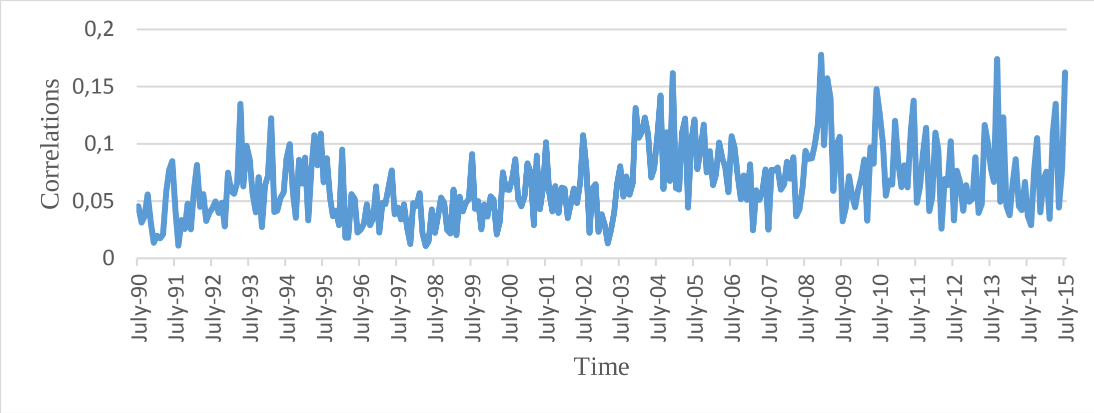

Figure A.6. Average Idiosyncratic Correlations from the FF3F Model for Local Industry Indexes

Table A.11. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for Idiosyncratic Correlations from the FF3F Model for Local Industry Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IDIO(-1)	-0.024502	-1.011889	0.3124
D(MEAN_IDIO(-1))	-0.707273	-11.834020	0.0000
D(MEAN_IDIO(-2))	-0.545045	-8.403150	0.0000
D(MEAN_IDIO(-3))	-0.261160	-4.516337	0.0000
The ADF Test Statistic		-1.011889	0.2797

Table A.12. Unit Root Test Statistics based on the Model with a Constant Term for Idiosyncratic Correlations from the FF3F Model for Local Industry Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IDIO(-1)	-0.301794	-4.185160	0.0000
D(MEAN_IDIO(-1))	-0.500651	-6.479648	0.0000
D(MEAN_IDIO(-2))	-0.407923	-5.695158	0.0000
D(MEAN_IDIO(-3))	-0.191858	-3.259239	0.0012
The ADF Test Statistic		-4.185160	0.0008

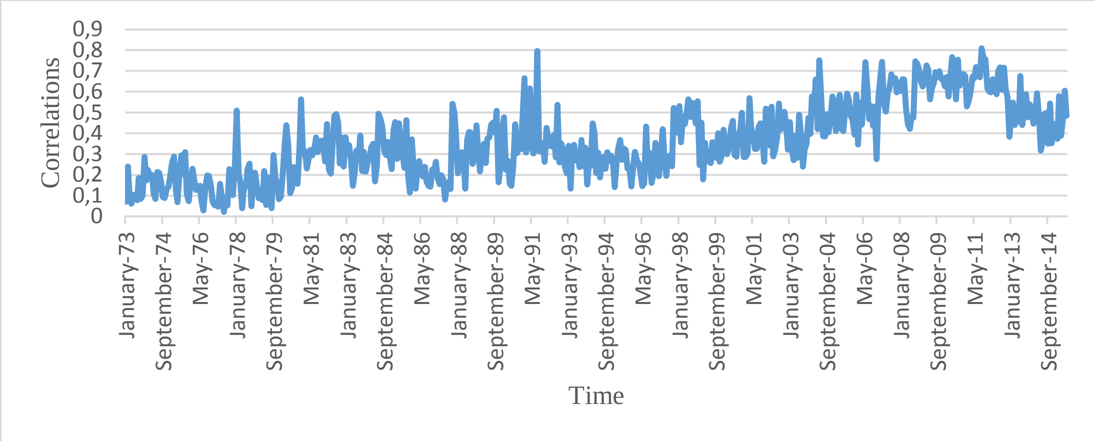

Figure A.7. Average Pair-wise Correlations for Local Country Indexes

Table A.13. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for Pair-wise Correlations of Local Country Indexes

Variable	Coefficient	t-Statistic	Prob.
RD_NAT(-1)	-0.004516	-0.398891	0.6901
D(RD_NAT(-1))	-0.648324	-14.241920	0.0000
D(RD_NAT(-2))	-0.551901	-10.435900	0.0000
D(RD_NAT(-3))	-0.450464	-7.946303	0.0000
D(RD_NAT(-4))	-0.303152	-5.370081	0.0000
D(RD_NAT(-5))	-0.236117	-4.509832	0.0000
D(RD_NAT(-6))	-0.145894	-3.271694	0.0011
The ADF Test Statistic		-0.398891	0.5399

Table A.14. Unit Root Test Statistics based on the Model with a Constant Term for Pair-wise Correlations of Local Country Indexes

Variable	Coefficient	t-Statistic	Prob.
RD_NAT(-1)	-0.067793	-2.388455	0.0173
D(RD_NAT(-1))	-0.597762	-11.990310	0.0000
D(RD_NAT(-2))	-0.510668	-9.235058	0.0000
D(RD_NAT(-3))	-0.417969	-7.209342	0.0000
D(RD_NAT(-4))	-0.279040	-4.891450	0.0000
D(RD_NAT(-5))	-0.219278	-4.172018	0.0000
D(RD_NAT(-6))	-0.136878	-3.073873	0.0022
The ADF Test Statistic		-2.388455	0.1455

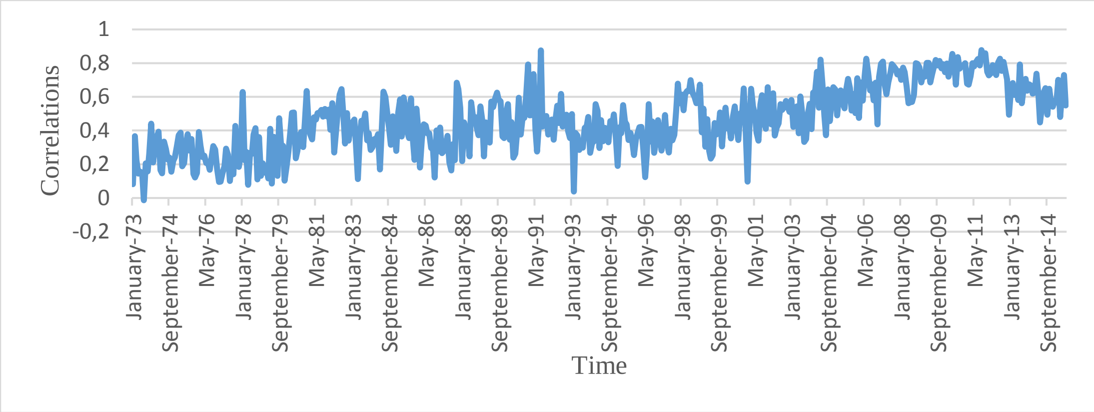

Figure A.8. Average Correlations against Global Market Return for Local Country Indexes

Table A.15. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for Correlations of Local Country Indexes against Global Market Return

Variable	Coefficient	t-Statistic	Prob.
AGAINST_GLOBAL(-1)	-0.004228	-0.413886	0.6791
D(AGAINST_GLOBAL(-1))	-0.640720	-14.288090	0.0000
D(AGAINST_GLOBAL(-2))	-0.548216	-10.575840	0.0000
D(AGAINST_GLOBAL(-3))	-0.440640	-8.220187	0.0000
D(AGAINST_GLOBAL(-4))	-0.257143	-4.999494	0.0000
D(AGAINST_GLOBAL(-5))	-0.193286	-4.394485	0.0000
The ADF Test Statistic		-0.413886	0.5340

Table A.16. Unit Root Test Statistics based on the Model with a Constant Term for Correlations of Local Country Indexes against Global Market Return

Variable	Coefficient	t-Statistic	Prob.
AGAINST_GLOBAL(-1)	-0.085115	-2.770445	0.0058
D(AGAINST_GLOBAL(-1))	-0.577005	-11.526980	0.0000
D(AGAINST_GLOBAL(-2))	-0.497094	-9.095514	0.0000
D(AGAINST_GLOBAL(-3))	-0.402552	-7.323492	0.0000
D(AGAINST_GLOBAL(-4))	-0.231430	-4.458036	0.0000
D(AGAINST_GLOBAL(-5))	-0.179329	-4.078119	0.0001
The ADF Test Statistic		-2.770445	0.0633

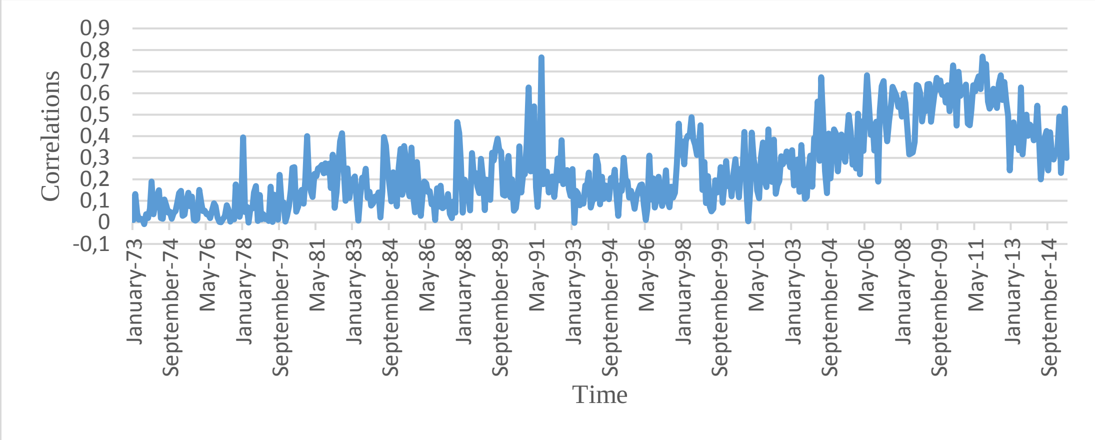

Figure A.9. Single-Factor Model Implied Correlations for Local Country Indexes

Table A.17. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for Single-Factor Model Implied Correlations of Local Country Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IMPLIED(-1)	-0.013464	-0.863669	0.3882
D(MEAN_IMPLIED(-1))	-0.632528	-13.593120	0.0000
D(MEAN_IMPLIED(-2))	-0.540248	-10.164110	0.0000
D(MEAN_IMPLIED(-3))	-0.446677	-7.816867	0.0000
D(MEAN_IMPLIED(-4))	-0.250729	-4.416002	0.0000
D(MEAN_IMPLIED(-5))	-0.246788	-4.719267	0.0000
D(MEAN_IMPLIED(-6))	-0.129554	-2.886250	0.0041
The ADF Test Statistic		-0.863669	0.3415

Table A.18. Unit Root Test Statistics based on the Model with a Constant Term for Single-Factor Model Implied Correlations of Local Country Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IMPLIED(-1)	-0.067735	-2.362808	0.0185
D(MEAN_IMPLIED(-1))	-0.589127	-11.737700	0.0000
D(MEAN_IMPLIED(-2))	-0.504854	-9.142608	0.0000
D(MEAN_IMPLIED(-3))	-0.418380	-7.178710	0.0000
D(MEAN_IMPLIED(-4))	-0.229825	-4.010693	0.0001
D(MEAN_IMPLIED(-5))	-0.231848	-4.416004	0.0000
D(MEAN_IMPLIED(-6))	-0.121554	-2.710557	0.0069
The ADF Test Statistic		-2.362808	0.1530

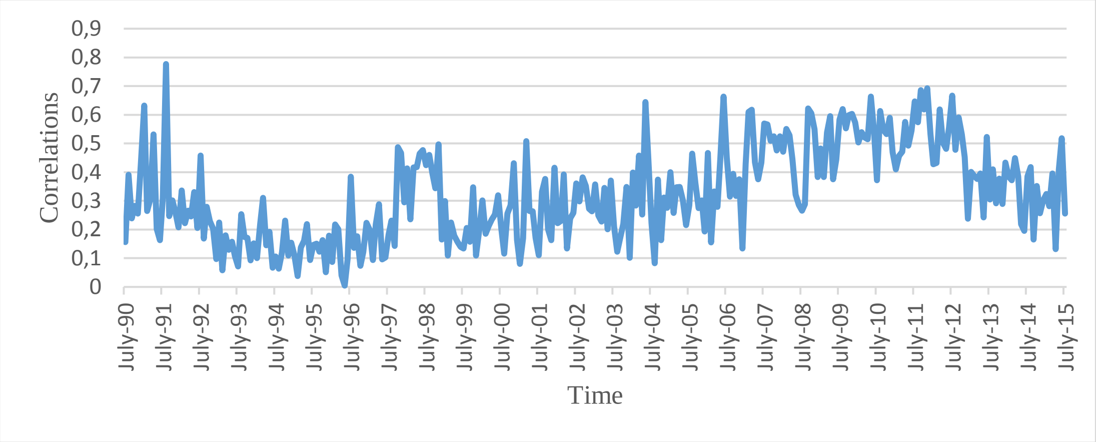

Figure A.10. Average FF3F Model Implied Correlations for Local Country Indexes

Table A.19. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for FF3F Model Implied Correlations of Local Country Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IMPLIED(-1)	-0.017894	-0.937056	0.3495
D(MEAN_IMPLIED(-1))	-0.678017	-11.259040	0.0000
D(MEAN_IMPLIED(-2))	-0.500134	-7.359466	0.0000
D(MEAN_IMPLIED(-3))	-0.393222	-5.788686	0.0000
D(MEAN_IMPLIED(-4))	-0.133289	-2.267064	0.0241
The ADF Test Statistic		-0.937056	0.3101

Table A.20. Unit Root Test Statistics based on the Model with a Constant Term for FF3F Model Implied Correlations of Local Country Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IMPLIED(-1)	-0.133502	-2.696193	0.0074
D(MEAN_IMPLIED(-1))	-0.586863	-8.416287	0.0000
D(MEAN_IMPLIED(-2))	-0.432058	-5.957097	0.0000
D(MEAN_IMPLIED(-3))	-0.346034	-4.953747	0.0000
D(MEAN_IMPLIED(-4))	-0.109606	-1.857530	0.0642
The ADF Test Statistic		-2.696193	0.0758

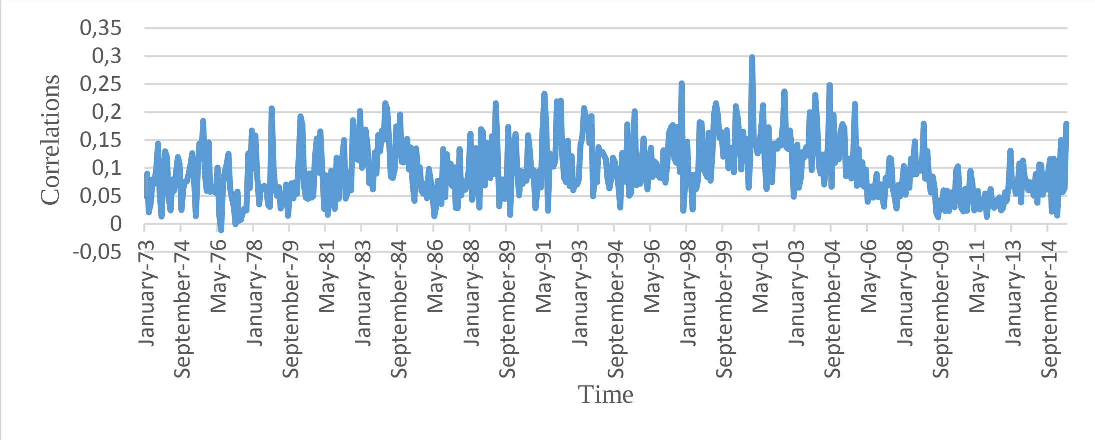

Figure A.11. Average Idiosyncratic Correlations from a Single-Factor Model for Local Country Indexes

Table A.21. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for Idiosyncratic Correlations from a Single-Factor Model for Local Country Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IDIO(-1)	-0.029531	-1.456364	0.1459
D(MEAN_IDIO(-1))	-0.663365	-13.924370	0.0000
D(MEAN_IDIO(-2))	-0.507872	-9.316269	0.0000
D(MEAN_IDIO(-3))	-0.351926	-6.125719	0.0000
D(MEAN_IDIO(-4))	-0.265613	-4.656790	0.0000
D(MEAN_IDIO(-5))	-0.274462	-5.155087	0.0000
D(MEAN_IDIO(-6))	-0.119436	-2.660526	0.0081
The ADF Test Statistic		-1.456364	0.1358

Table A.22. Unit Root Test Statistics based on the Model with a Constant Term for Idiosyncratic Correlations from a Single-Factor Model for Local Country Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IDIO(-1)	-0.413479	-7.907578	0.0000
D(MEAN_IDIO(-1))	-0.301569	-5.726740	0.0000
D(MEAN_IDIO(-2))	-0.167574	-3.806025	0.0002
The ADF Test Statistic		-7.907578	0.0000

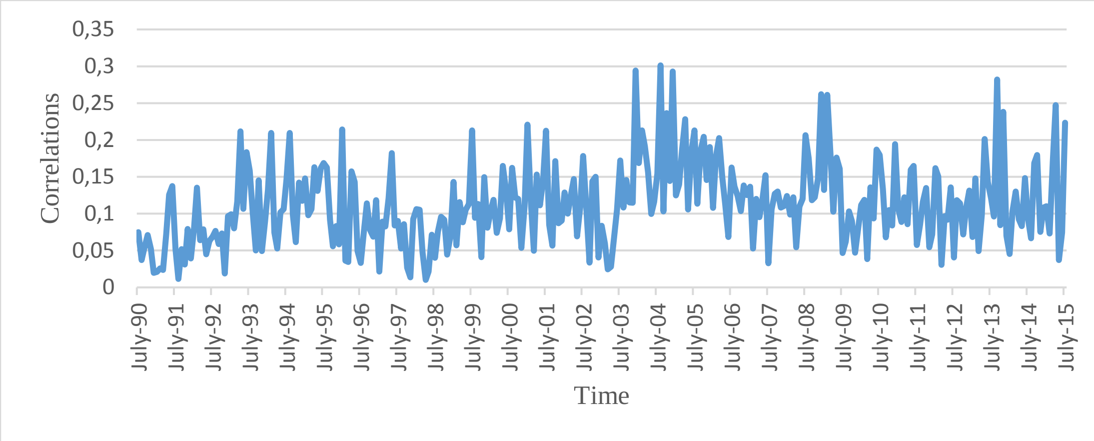

Figure A.12. Average Idiosyncratic Correlations from the FF3F Model for Local Country Indexes

Table A.23. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for Idiosyncratic Correlations from the FF3F Model for Local Country Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IDIO(-1)	-0.019829	-0.760363	0.4477
D(MEAN_IDIO(-1))	-0.800819	-12.932270	0.0000
D(MEAN_IDIO(-2))	-0.719372	-9.512112	0.0000
D(MEAN_IDIO(-3))	-0.512936	-6.338708	0.0000
D(MEAN_IDIO(-4))	-0.274361	-3.648966	0.0003
D(MEAN_IDIO(-5))	-0.197210	-3.328892	0.0010
The ADF Test Statistic		-0.760363	0.3863

Table A.24. Unit Root Test Statistics based on the Model with a Constant Term for Idiosyncratic Correlations from the FF3F Model for Local Country Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IDIO(-1)	-0.417911	-5.039749	0.0000
D(MEAN_IDIO(-1))	-0.443625	-5.402742	0.0000
D(MEAN_IDIO(-2))	-0.380646	-5.188996	0.0000
D(MEAN_IDIO(-3))	-0.204140	-3.489879	0.0006
The ADF Test Statistic		-5.039749	0.0000

Table A.25. Mean Difference Test Statistics between Pair-wise Correlations for Local Industry and Local Country Indexes

Mean Correlation of Local Industry Indexes	Mean Correlation of Local Country Indexes	Mean Difference	t-Statistic	Prob.
0.197571	0.360476	-0.162905	-17.434600	0.0000

Table A.26. Mean Difference Test Statistics between Correlations against Global Market Return for Local Industry and Local Country Indexes

Mean Correlation of Local Industry Indexes	Mean Correlation of Local Country Indexes	Mean Difference	t-Statistic	Prob.
0.339106	0.468447	-0.129341	-12.128450	0.0000

Table A.27. Mean Difference Test Statistics between Single-Factor Model Implied Correlations for Local Industry and Local Country Indexes

Mean Correlation of Local Industry Indexes	Mean Correlation of Local Country Indexes	Mean Difference	t-Statistic	Prob.
0.136629	0.252763	-0.116134	-12.016640	0.0000

Table A.28. Mean Difference Test Statistics between FF3F Model Implied Correlations for Local Industry and Local Country Indexes

Mean Correlation of Local Industry Indexes	Mean Correlation of Local Country Indexes	Mean Difference	t-Statistic	Prob.
0.166278	0.323826	-0.15755	-13.79246	0.0000

Table A.29. Mean Difference Test Statistics between Idiosyncratic Correlations from a Single-Factor Model for Local Industry and Local Country Indexes

Mean Correlation of Local Industry Indexes	Mean Correlation of Local Country Indexes	Mean Difference	t-Statistic	Prob.
0.059982	0.096552	-0.036570	-14.296520	0.0000

Table A.30. Mean Difference Test Statistics between Idiosyncratic Correlations from the FF3F Model for Local Industry and Local Country Indexes

Mean Correlation of Local Industry Indexes	Mean Correlation of Local Country Indexes	Mean Difference	t-Statistic	Prob.
0.06499	0.112114	-0.04712	-12.77907	0.0000

APPENDIX B

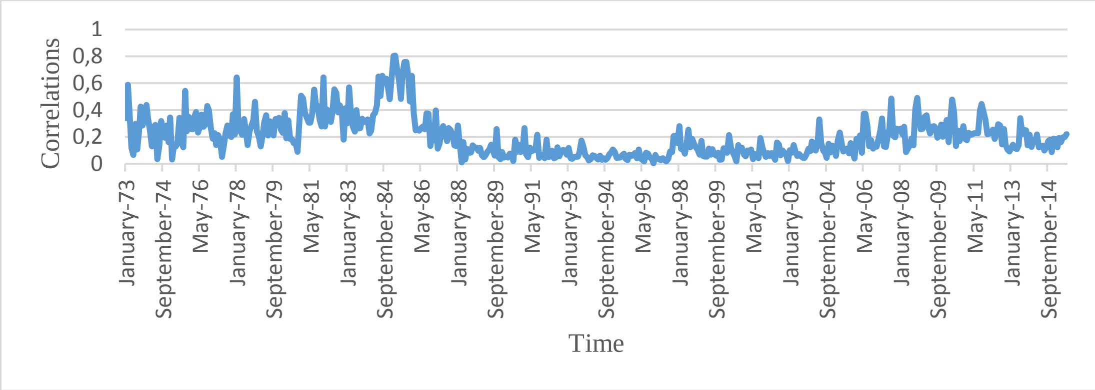

Figure B.1. Average Pair-wise Correlations for Local Industry Indexes

Table B.1. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for Pair-wise Correlations of Local Industry Indexes

Variable	Coefficient	t-Statistic	Prob.
MEANCOR(-1)	-0.028615	-1.768716	0.0775
D(MEANCOR(-1))	-0.526947	-11.616850	0.0000
D(MEANCOR(-2))	-0.352524	-7.178475	0.0000
D(MEANCOR(-3))	-0.213797	-4.434166	0.0000
D(MEANCOR(-4))	-0.144799	-3.355966	0.0009
The ADF Test Statistic		-1.768716	0.073100

Table B.2. Unit Root Test Statistics based on the Model with a Constant Term for Pair-wise Correlations of Local Industry Indexes

Variable	Coefficient	t-Statistic	Prob.
MEANCOR(-1)	-0.095620	-3.264013	0.0012
D(MEANCOR(-1))	-0.476826	-9.800970	0.0000
D(MEANCOR(-2))	-0.313821	-6.177202	0.0000
D(MEANCOR(-3))	-0.185822	-3.793382	0.0002
D(MEANCOR(-4))	-0.127946	-2.954146	0.0033
The ADF Test Statistic		-3.264013	0.0171

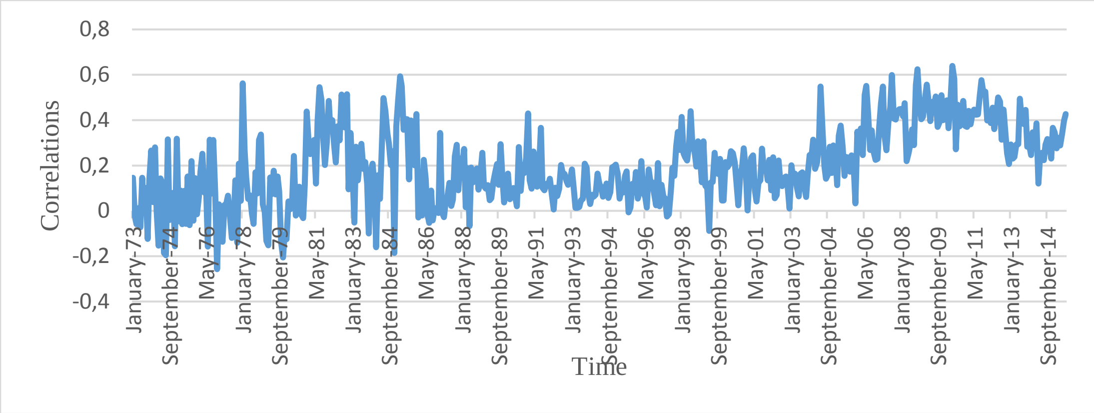

Figure B.2. Average Correlations against Global Market Return for Local Industry Indexes

Table B.3. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for Correlations of Local Industry Indexes against Global Market Return

Variable	Coefficient	t-Statistic	Prob.
AGAINST_GLOBAL(-1)	-0.027130	-1.215576	0.2247
D(AGAINST_GLOBAL(-1))	-0.620968	-12.894560	0.0000
D(AGAINST_GLOBAL(-2))	-0.426924	-7.838016	0.0000
D(AGAINST_GLOBAL(-3))	-0.386361	-6.863337	0.0000
D(AGAINST_GLOBAL(-4))	-0.354962	-6.319655	0.0000
D(AGAINST_GLOBAL(-5))	-0.244255	-4.424467	0.0000
D(AGAINST_GLOBAL(-6))	-0.213733	-4.084324	0.0001
D(AGAINST_GLOBAL(-7))	-0.168820	-3.815762	0.0002
The ADF Test Statistic		-1.215576	0.2057

Table B.4. Unit Root Test Statistics based on the Model with a Constant Term for Correlations of Local Industry Indexes against Global Market Return

Variable	Coefficient	t-Statistic	Prob.
AGAINST_GLOBAL(-1)	-0.112801	-2.831977	0.0048
D(AGAINST_GLOBAL(-1))	-0.550820	-10.012880	0.0000
D(AGAINST_GLOBAL(-2))	-0.367871	-6.260478	0.0000
D(AGAINST_GLOBAL(-3))	-0.336544	-5.686378	0.0000
D(AGAINST_GLOBAL(-4))	-0.314661	-5.427618	0.0000
D(AGAINST_GLOBAL(-5))	-0.213410	-3.799560	0.0002
D(AGAINST_GLOBAL(-6))	-0.190945	-3.618451	0.0003
D(AGAINST_GLOBAL(-7))	-0.155626	-3.514302	0.0005
The ADF Test Statistic		-2.831977	0.0545

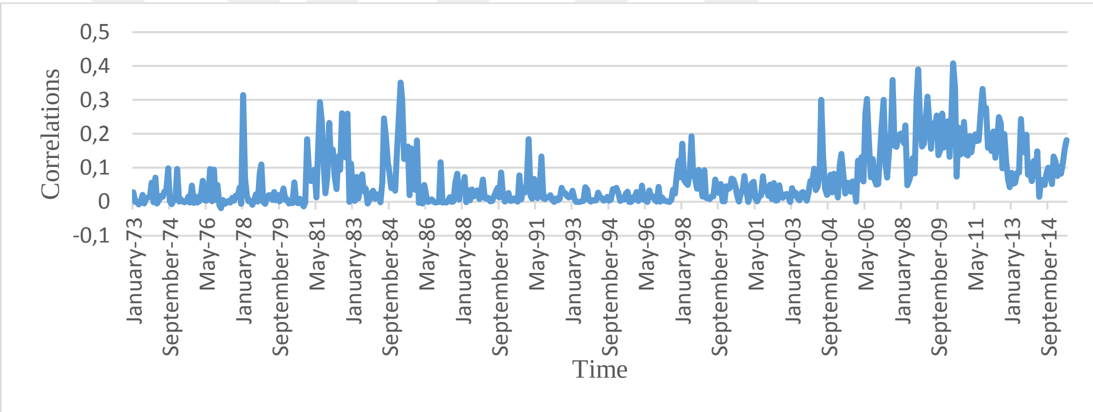

Figure B.3. Single-Factor Model Implied Correlations for Local Industry Indexes

Table B.5. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for Single-Factor Model Implied Correlations of Local Industry Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IMPLIED(-1)	-0.071165	-2.672595	0.0078
D(MEAN_IMPLIED(-1))	-0.419821	-8.804657	0.0000
D(MEAN_IMPLIED(-2))	-0.340815	-6.917364	0.0000
D(MEAN_IMPLIED(-3))	-0.238073	-4.952770	0.0000
D(MEAN_IMPLIED(-4))	-0.201808	-4.596117	0.0000
The ADF Test Statistic		-2.672595	0.0074

Table B.6. Unit Root Test Statistics based on the Model with a Constant Term for Single-Factor Model Implied Correlations of Local Industry Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IMPLIED(-1)	-0.150396	-4.053019	0.0001
D(MEAN_IMPLIED(-1))	-0.362013	-7.101811	0.0000
D(MEAN_IMPLIED(-2))	-0.295670	-5.788813	0.0000
D(MEAN_IMPLIED(-3))	-0.205842	-4.214370	0.0000
D(MEAN_IMPLIED(-4))	-0.181820	-4.128018	0.0000
The ADF Test Statistic		-4.053019	0.0013

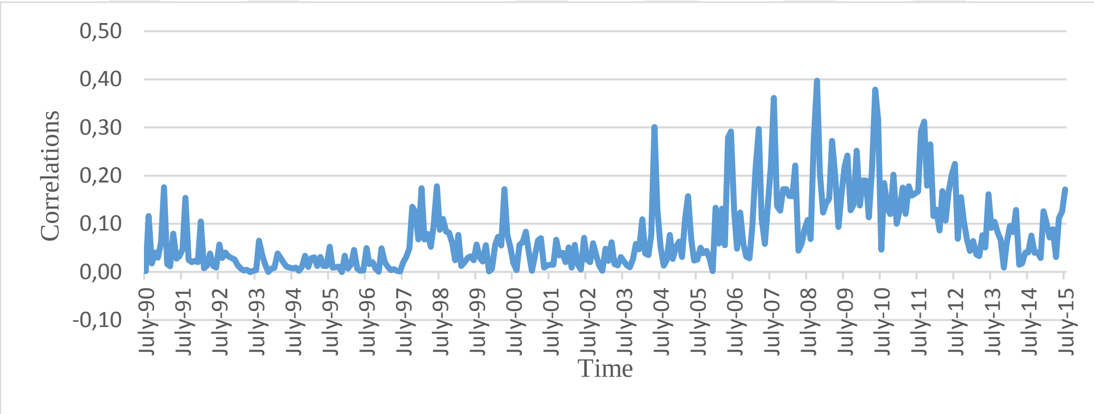

Figure B.4. Average FF3F Model Implied Correlations for Local Industry Indexes

Table B.7. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for FF3F Model Implied Correlations of Local Industry Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IMPLIED(-1)	-0.060256	-1.805239	0.0721
D(MEAN_IMPLIED(-1))	-0.422200	-6.736561	0.0000
D(MEAN_IMPLIED(-2))	-0.433039	-6.787851	0.0000
D(MEAN_IMPLIED(-3))	-0.304601	-4.903556	0.0000
D(MEAN_IMPLIED(-4))	-0.186600	-3.239676	0.0013
The ADF Test Statistic		-1.805239	0.0676

Table B.8. Unit Root Test Statistics based on the Model with a Constant Term for FF3F Model Implied Correlations of Local Industry Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IMPLIED(-1)	-0.169387	-3.200271	0.0015
D(MEAN_IMPLIED(-1))	-0.340258	-4.904599	0.0000
D(MEAN_IMPLIED(-2))	-0.368921	-5.452281	0.0000
D(MEAN_IMPLIED(-3))	-0.260548	-4.089181	0.0001
D(MEAN_IMPLIED(-4))	-0.160985	-2.783426	0.0057
The ADF Test Statistic		-3.200271	0.0210

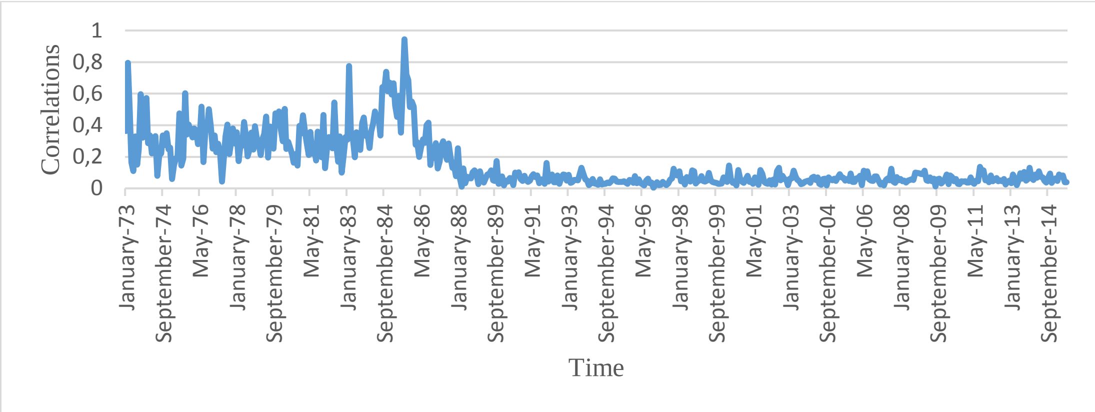

Figure B.5. Average Idiosyncratic Correlations from a Single-Factor Model for Local Industry Indexes

Table B.9. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for Idiosyncratic Correlations from a Single-Factor Model for Local Industry Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IDIO(-1)	-0.025336	-1.571945	0.1166
D(MEAN_IDIO(-1))	-0.636948	-13.855610	0.0000
D(MEAN_IDIO(-2))	-0.419994	-7.957192	0.0000
D(MEAN_IDIO(-3))	-0.237622	-4.324651	0.0000
D(MEAN_IDIO(-4))	-0.291607	-5.417422	0.0000
D(MEAN_IDIO(-5))	-0.218482	-4.161115	0.0000
D(MEAN_IDIO(-6))	-0.224714	-4.614054	0.0000
D(MEAN_IDIO(-7))	-0.158810	-3.823283	0.0001
The ADF Test Statistic		-1.571945	0.1091

Table B.10. Unit Root Test Statistics based on the Model with a Constant Term for Idiosyncratic Correlations from a Single-Factor Model for Local Industry Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IDIO(-1)	-0.043477	-1.841290	0.0662
D(MEAN_IDIO(-1))	-0.621618	-12.890380	0.0000
D(MEAN_IDIO(-2))	-0.407049	-7.510983	0.0000
D(MEAN_IDIO(-3))	-0.226465	-4.047202	0.0001
D(MEAN_IDIO(-4))	-0.282057	-5.167457	0.0000
D(MEAN_IDIO(-5))	-0.210592	-3.970895	0.0001
D(MEAN_IDIO(-6))	-0.218865	-4.465391	0.0000
D(MEAN_IDIO(-7))	-0.155390	-3.729921	0.0002
The ADF Test Statistic		-1.841290	0.3603

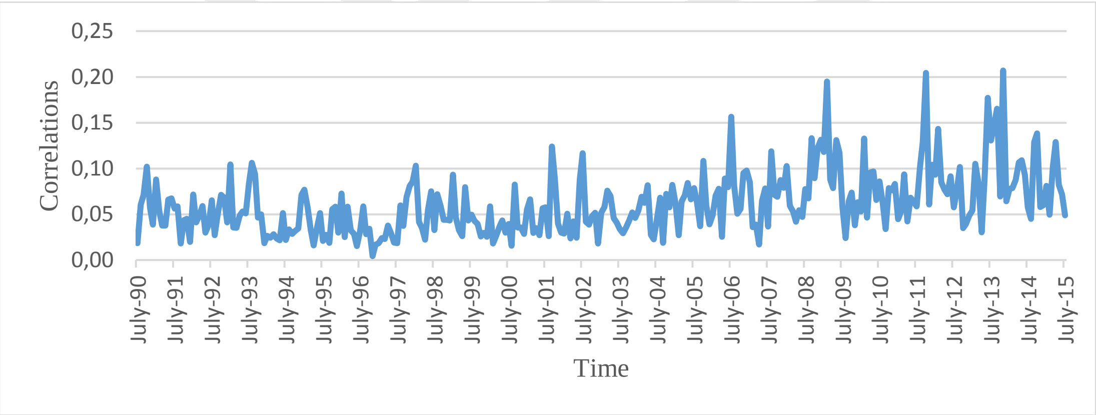

Figure B.6. Average Idiosyncratic Correlations from the FF3F Model for Local Industry Indexes

Table B.11. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for Idiosyncratic Correlations from the FF3F Model for Local Industry Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IDIO(-1)	-0.038028	-1.434002	0.1526
D(MEAN_IDIO(-1))	-0.623878	-10.205840	0.0000
D(MEAN_IDIO(-2))	-0.443910	-6.509685	0.0000
D(MEAN_IDIO(-3))	-0.318806	-4.730370	0.0000
D(MEAN_IDIO(-4))	-0.182362	-3.160311	0.0017
The ADF Test Statistic		-1.434002	0.1413

Table B.12. Unit Root Test Statistics based on the Model with a Constant Term for Idiosyncratic Correlations from the FF3F Model for Local Industry Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IDIO(-1)	-0.439926	-7.336628	0.0000
D(MEAN_IDIO(-1))	-0.212045	-3.743146	0.0002
The ADF Test Statistic		-7.336628	0.0000

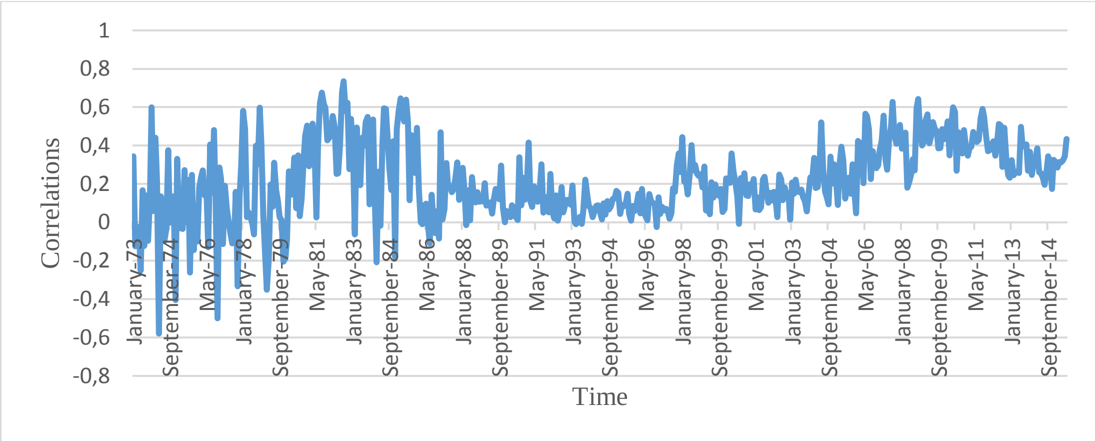

Figure B.7. Average Pair-wise Correlations for Local Country Indexes

Table B.13. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for Pair-wise Correlations of Local Country Indexes

Variable	Coefficient	t-Statistic	Prob.
RD_NAT(-1)	-0.029987	-1.177210	0.2397
D(RD_NAT(-1))	-0.670744	-13.426730	0.0000
D(RD_NAT(-2))	-0.501391	-8.953780	0.0000
D(RD_NAT(-3))	-0.385930	-6.653550	0.0000
D(RD_NAT(-4))	-0.449677	-7.849062	0.0000
D(RD_NAT(-5))	-0.397167	-7.029118	0.0000
D(RD_NAT(-6))	-0.324614	-5.787510	0.0000
D(RD_NAT(-7))	-0.328630	-6.234151	0.0000
D(RD_NAT(-8))	-0.116735	-2.642242	0.0085
The ADF Test Statistic		-1.177210	0.2187

Table B.14. Unit Root Test Statistics based on the Model with a Constant Term for Pair-wise Correlations of Local Country Indexes

Variable	Coefficient	t-Statistic	Prob.
RD_NAT(-1)	-0.146142	-3.148992	0.0017
D(RD_NAT(-1))	-0.548666	-9.493315	0.0000
D(RD_NAT(-2))	-0.386388	-6.385033	0.0000
D(RD_NAT(-3))	-0.279008	-4.684896	0.0000
D(RD_NAT(-4))	-0.342506	-6.034865	0.0000
D(RD_NAT(-5))	-0.309285	-5.544412	0.0000
D(RD_NAT(-6))	-0.233046	-4.445529	0.0000
D(RD_NAT(-7))	-0.224197	-5.186200	0.0000
The ADF Test Statistic		-3.148992	0.0238

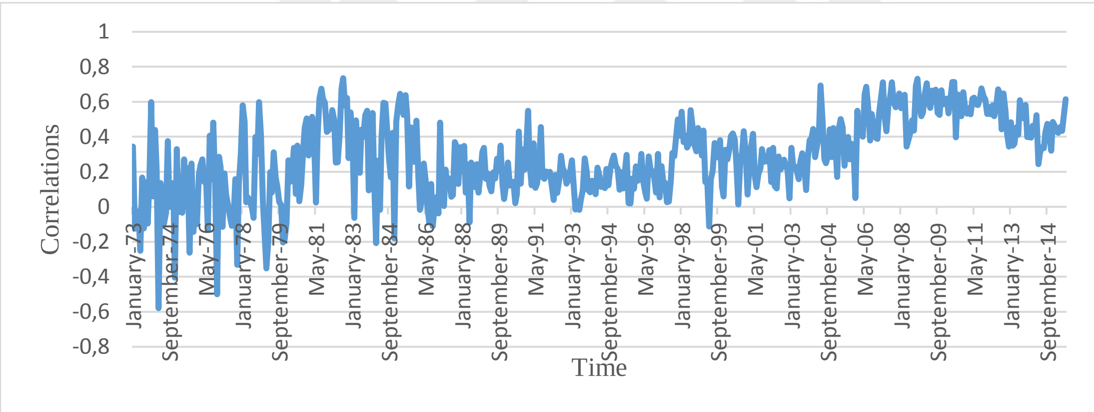

Figure B.8. Average Correlations against Global Market Return for Local Country Indexes

Table B.15. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for Correlations of Local Country Indexes against Global Market Return

Variable	Coefficient	t-Statistic	Prob.
AGAINST_GLOBAL(-1)	-0.016493	-0.783726	0.4336
D(AGAINST_GLOBAL(-1))	-0.666098	-13.720070	0.0000
D(AGAINST_GLOBAL(-2))	-0.516526	-9.401242	0.0000
D(AGAINST_GLOBAL(-3))	-0.413866	-7.188332	0.0000
D(AGAINST_GLOBAL(-4))	-0.456871	-7.941148	0.0000
D(AGAINST_GLOBAL(-5))	-0.389691	-6.844856	0.0000
D(AGAINST_GLOBAL(-6))	-0.309851	-5.517210	0.0000
D(AGAINST_GLOBAL(-7))	-0.315553	-6.005963	0.0000
D(AGAINST_GLOBAL(-8))	-0.107014	-2.414089	0.0161
The ADF Test Statistic		-0.783726	0.3764

Table B.16. Unit Root Test Statistics based on the Model with a Constant Term for Correlations of Local Country Indexes against Global Market Return

Variable	Coefficient	t-Statistic	Prob.
AGAINST_GLOBAL(-1)	-0.112158	-2.755043	0.0061
D(AGAINST_GLOBAL(-1))	-0.564205	-10.280390	0.0000
D(AGAINST_GLOBAL(-2))	-0.420501	-7.186663	0.0000
D(AGAINST_GLOBAL(-3))	-0.323906	-5.539595	0.0000
D(AGAINST_GLOBAL(-4))	-0.364140	-6.465522	0.0000
D(AGAINST_GLOBAL(-5))	-0.311695	-5.622550	0.0000
D(AGAINST_GLOBAL(-6))	-0.228961	-4.397757	0.0000
D(AGAINST_GLOBAL(-7))	-0.223422	-5.158811	0.0000
The ADF Test Statistic		-2.755043	0.0657

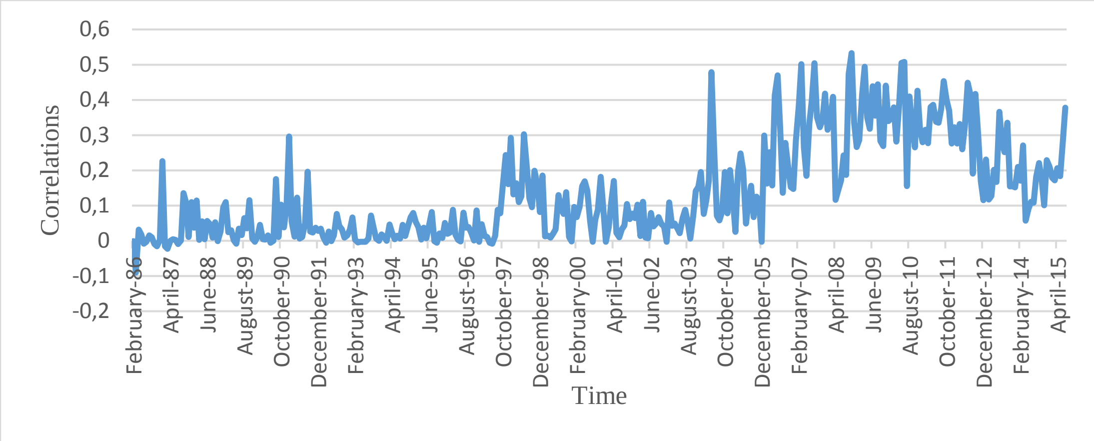

Figure B.9. Single-Factor Model Implied Correlations for Local Country Indexes

Table B.17. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for Single-Factor Model Implied Correlations of Local Country Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IMPLIED(-1)	-0.027149	-1.184844	0.2369
D(MEAN_IMPLIED(-1))	-0.518118	-9.238074	0.0000
D(MEAN_IMPLIED(-2))	-0.463540	-7.728863	0.0000
D(MEAN_IMPLIED(-3))	-0.307100	-5.206949	0.0000
D(MEAN_IMPLIED(-4))	-0.185171	-3.471793	0.0006
The ADF Test Statistic		-1.184844	0.2159

Table B.18. Unit Root Test Statistics based on the Model with a Constant Term for Single-Factor Model Implied Correlations of Local Country Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IMPLIED(-1)	-0.078918	-2.324374	0.0207
D(MEAN_IMPLIED(-1))	-0.480046	-8.162965	0.0000
D(MEAN_IMPLIED(-2))	-0.434709	-7.089611	0.0000
D(MEAN_IMPLIED(-3))	-0.288554	-4.858551	0.0000
D(MEAN_IMPLIED(-4))	-0.174710	-3.276053	0.0012
The ADF Test Statistic		-2.324374	0.1649

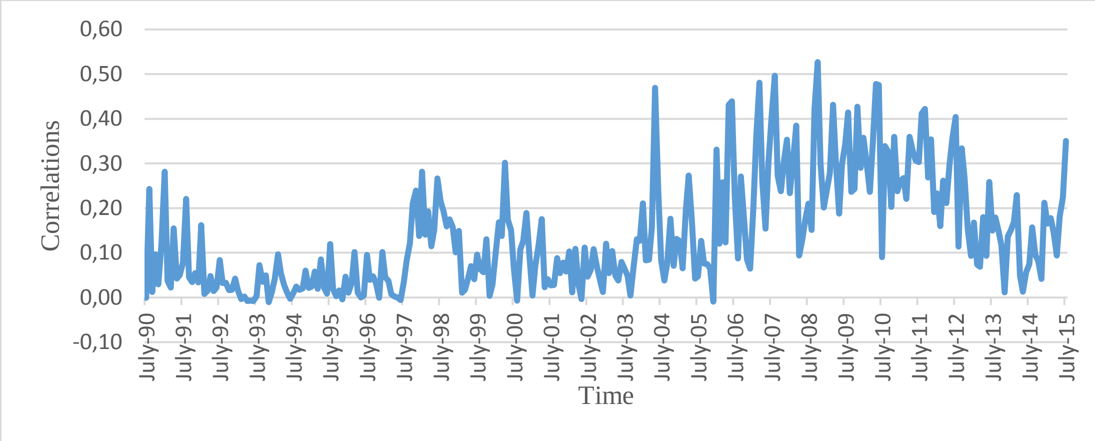

Figure B.10. Average FF3F Model Implied Correlations for Local Country Indexes

Table B.19. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for FF3F Model Implied Correlations of Local Country Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IMPLIED(-1)	-0.036805	-1.300946	0.1943
D(MEAN_IMPLIED(-1))	-0.519411	-8.416983	0.0000
D(MEAN_IMPLIED(-2))	-0.470924	-7.312923	0.0000
D(MEAN_IMPLIED(-3))	-0.370810	-5.867485	0.0000
D(MEAN_IMPLIED(-4))	-0.192740	-3.368614	0.0009
The ADF Test Statistic		-1.300946	0.1784

Table B.20. Unit Root Test Statistics based on the Model with a Constant Term for FF3F Model Implied Correlations of Local Country Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IMPLIED(-1)	-0.124388	-2.628601	0.0090
D(MEAN_IMPLIED(-1))	-0.452403	-6.668962	0.0000
D(MEAN_IMPLIED(-2))	-0.419833	-6.203438	0.0000
D(MEAN_IMPLIED(-3))	-0.335354	-5.190927	0.0000
D(MEAN_IMPLIED(-4))	-0.173788	-3.027968	0.0027
The ADF Test Statistic		-2.628601	0.0883

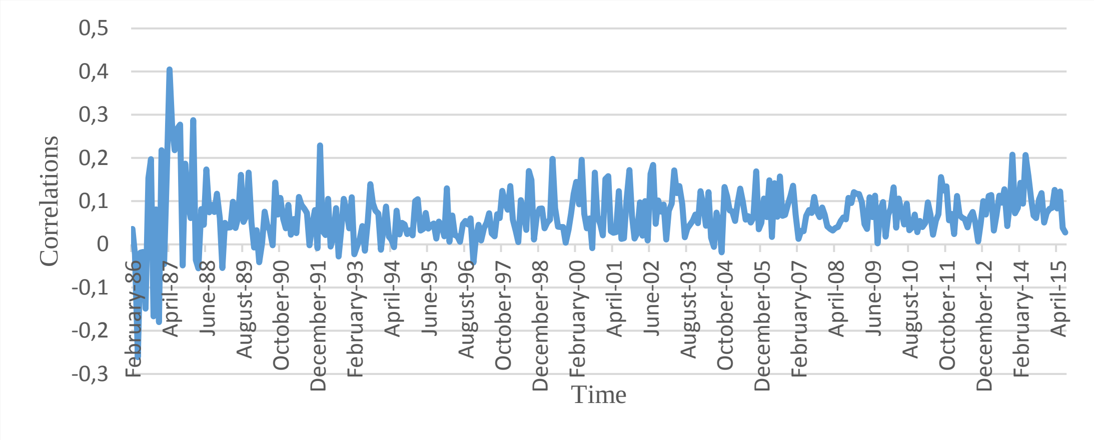

Figure B.11. Average Idiosyncratic Correlations from a Single-Factor Model for Local Country Indexes

Table B.21. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for Idiosyncratic Correlations from a Single-Factor Model for Local Country Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IDIO(-1)	-0.067326	-1.587449	0.1134
D(MEAN_IDIO(-1))	-0.741700	-11.530220	0.0000
D(MEAN_IDIO(-2))	-0.517677	-6.998896	0.0000
D(MEAN_IDIO(-3))	-0.335692	-4.458825	0.0000
D(MEAN_IDIO(-4))	-0.355473	-4.793572	0.0000
D(MEAN_IDIO(-5))	-0.263946	-3.638245	0.0003
D(MEAN_IDIO(-6))	-0.318355	-4.510183	0.0000
D(MEAN_IDIO(-7))	-0.259303	-4.039217	0.0001
D(MEAN_IDIO(-8))	-0.158032	-3.161275	0.0017
The ADF Test Statistic		-1.587449	0.1058

Table B.22. Unit Root Test Statistics based on the Model with a Constant Term for Idiosyncratic Correlations from a Single-Factor Model for Local Country Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IDIO(-1)	-0.627746	-8.375818	0.0000
D(MEAN_IDIO(-1))	-0.280685	-4.200454	0.0000
D(MEAN_IDIO(-2))	-0.164011	-3.220263	0.0014
The ADF Test Statistic		-8.375818	0.0000

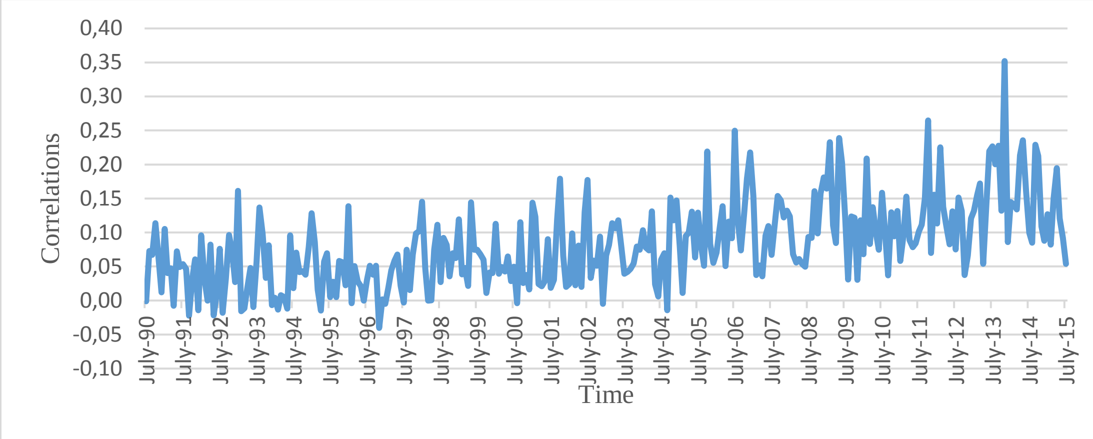

Figure B.12. Average Idiosyncratic Correlations from the FF3F Model for Local Country Indexes

Table B.23. Unit Root Test Statistics based on the Model without a Constant Term and Linear Trend for Idiosyncratic Correlations from the FF3F Model for Local Country Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IDIO(-1)	-0.051693	-1.560325	0.1198
D(MEAN_IDIO(-1))	-0.678409	-10.755910	0.0000
D(MEAN_IDIO(-2))	-0.523921	-7.548514	0.0000
D(MEAN_IDIO(-3))	-0.419238	-6.160721	0.0000
D(MEAN_IDIO(-4))	-0.209390	-3.634024	0.0003
The ADF Test Statistic		-1.560325	0.1115

Table B.24. Unit Root Test Statistics based on the Model with a Constant Term for Idiosyncratic Correlations from the FF3F Model for Local Country Indexes

Variable	Coefficient	t-Statistic	Prob.
MEAN_IDIO(-1)	-0.246396	-3.553437	0.0004
D(MEAN_IDIO(-1))	-0.524066	-6.650350	0.0000
D(MEAN_IDIO(-2))	-0.408186	-5.272407	0.0000
D(MEAN_IDIO(-3))	-0.340350	-4.763700	0.0000
D(MEAN_IDIO(-4))	-0.169498	-2.917087	0.0038
The ADF Test Statistic		-3.553437	0.0073

Table B.25. Mean Difference Test Statistics between Pair-wise Correlations for Local Industry and Local Country Indexes

Mean Correlation of Local Industry Indexes	Mean Correlation of Local Country Indexes	Mean Difference	t-Statistic	Prob.
0.201985	0.218467	-0.016482	-1.502512	0.1333

Table B.26. Mean Difference Test Statistics between Correlations against Global Market Return for Local Industry and Local Country Indexes

Mean Correlation of Local Industry Indexes	Mean Correlation of Local Country Indexes	Mean Difference	t-Statistic	Prob.
0.198475	0.287366	-0.088891	-7.122323	0.0000

Table B.27. Mean Difference Test Statistics between Single-Factor Model Implied Correlations for Local Industry and Local Country Indexes

Mean Correlation of Local Industry Indexes	Mean Correlation of Local Country Indexes	Mean Difference	t-Statistic	Prob.
0.072661	0.135508	-0.062847	-7.339214	0.0000

Table B.28. Mean Difference Test Statistics between FF3F Model Implied Correlations for Local Industry and Local Country Indexes

Mean Correlation of Local Industry Indexes	Mean Correlation of Local Country Indexes	Mean Difference	t-Statistic	Prob.
0.07713	0.139921	-0.06279	-7.469011	0.0000

Table B.29. Mean Difference Test Statistics between Idiosyncratic Correlations from a Single-Factor Model for Local Industry and Local Country Indexes

Mean Correlation of Local Industry Indexes	Mean Correlation of Local Country Indexes	Mean Difference	t-Statistic	Prob.
0.070019	0.068556	0.001463	0.322077	0.7475

Table B.30. Mean Difference Test Statistics between Idiosyncratic Correlations from the FF3F Model for Local Industry and Local Country Indexes

Mean Correlation of Local Industry Indexes	Mean Correlation of Local Country Indexes	Mean Difference	t-Statistic	Prob.
0.061111	0.082298	-0.02119	-5.231432	0.0000