Distribution-Free Performance Evaluation of Emerging and Developed Stock Market Investments: A Spatial Dominance Approach

Charlie Cai*, Minjoo Kim† and Yongcheol Shin‡
Leeds University Business School

Abstract

Comparing investments opportunities in emerging and developed market is an important issue in international portfolio management. However, it is well-established that the stock market returns are non-normal and have time-varying moments. This creates a challenge in ranking alternative investment strategies especially in a dynamic setting. We propse a distribution-free test based on a spatial dominance approach introduced by Park (2007) which is more general than the stochastic dominance approach allowing us to compare the sum of utilities obtained from alternative investments accumulated over a certain holding period instead of at the fixed point between the intervals. Applying the proposed test, we find that investments in emerging market is indifferent from their developed market counterparts for all investment horizon ranging from 3 month to 5 year, only if the currency risk is explicitly taken into account of. This suggests an integration between the two markets according to definition byBekaert and Harvey (2003). We also find that the returns of emerging market denominated in the local currency dominate those in the US dollar over 1- and 5-year investment horizons, implying that there is still an insufficient interaction between equity prices and foreign exchange rates in emerging markets in the longer-term. As expected, currency risk is found to be mostly irrelevant for developed market investments.

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*Leeds University Business School, Leeds, LS2 9JT, UK. Email: bnmk@leeds.ac.uk
†Leeds University Business School, Leeds, LS2 9JT, UK. Email: m.kim.lubs@googlemail.com
‡Leeds University Business School, Leeds, LS2 9JT, UK. Email: y.shin@leeds.ac.uk.

1 Introduction

Emerging market investment is an increasingly important component in the global portfolio management, and plays a key role in international diversification. (See, Harvey (1994a,b)). When investment opportunities in developed world offer lower growth prospects, the capital tends to flow to emerging markets. By investing in emerging markets, international investors can benefit from the higher growth but also enjoy diversification by taking advantage of market segmentation on a global scale (Sohnke and Dufey, 2001). Emerging market investments are often characterized by high average return combined with high volatility. There are several risk factors associated with emerging markets such as the currency devaluation, the failed economic plan, regulatory changes, and political risks. Hence, an analysis of the emerging market investment performance relative to the developed counterpart is important in making an efficient portfolio choice.

Recent developments in financial economics have highlight two challenges in ranking alternative investments. First, asset return distributions are found to be non-normal and time varying. Bekaert and Harvey (1997) point out that most empirical findings on the emerging versus the development market performance based on the conventional mean-variance (MV) and the asset pricing modelling approach should be interpreted with extreme care. These results are likely to be misleading in the case where the return distribution is non-normal and time varying and/or where investors' utility functions are not quadratic. Second, the time varying nature of return distribution post further challenge in evaluating investment portformance in different investment horizon[1]. Levy and Duchin (2004) emphasis the importance of investment horizon on asset return distributions which ultimately affects the choice of tool in evaluating the investment performance. They suggest that if the same theoretical distribution fits all horizons' return, one investment rule should be used. Otherwise, more than one investment rule may be appropriate. They show that no single distribution is best fit for both short (up to 1 year) and long (larger than 3 year) investment horizons. They show that the MV analysis is an optimal investment rule only for short term investment horizon.

Given the above challenges, an alternative approach based on the stochastic dominance (SD) offers superior criteria to compare relative performance of different investments. SD has less restrictive assumptions, incorporates information on the entire return distribution, and requires no specific form of the investor's utility function. Therefore, it provides rules for unambiguous ranking of risky choices based on utility theory rather than narrowly specified asset pricing models [2].

[1]Heterogeneous investment horizons has been documented in the literature. Johnson (2004) shows that the variations in investors' liquidity needs leads to an heterogeneous investment horizons phenomenon according to duration model.

[2]See, e.g. Levy (1992) for a survey of the early literature for the use of SD approach in analyzing economic behaviors under uncertainty.

However, difficulties arise, however, when an attemp is made to implement the SD test on different investment horizon with the underlining return distribution is time varying. It only consider the return distribution of the end points of a planed return horizon and ignore the important dynamic in between the these points. For example, if one interest in evaluating the investment performance of return over one year period. SD would use a series of annual return to evaluate the performance. This ignores the important information contain in the daily return distributions inbetween the investment horizons.

The current paper aims to provide an advance over the existing literature in a few respects. First, we propose a distribution-free test for comparing the performance of alternative investments over a term structure of the holding periods by using a spatial dominance (SPD) approach introduced by Park (2007). The important advantage of spatial dominance over stochastic dominance approach is that it allows us to explicitly make a comparison of the sum of utilities obtained from alternative investments accumulated over a certain holding period instead of at the fixed point of time. This provides us an useful tool in examining the effects of the investment horizons for alternative investments having time varying distribution.

Secondly, this paper aims to shed lights on a debate on the market integration and segmentation hypotheses, which is central in emerging market investment studies. Bekaert and Harvey (2003) define that markets are integrated when assets with an identical risk command the same expected return irrespective of their domicile. Given this definition, there should be no dominance found between investment the emerging and developed markets if the world market is integrated. It is well document that the correlation of the emerging market returns and the world market return is low and shifting through time. Harvey (1995) finds that the addition of the emerging markets to the portfolio selection significantly shift the investment opportunity set. Bekaert et al. (2007) point out that a simple implementation of the Capital Asset Pricing Model (CAPM) is problematic. In these markets, there is no relation between the risk measured by the CAPM and expected returns. Risk measured in the higher moment of the return distribution may be relevant, e.g. Harvey and Siddique (2000). Our methodology provides a more general test in market integration in that it studies the market integration from investor's utility point of view and incorporates comparisons on the whole return distribution between alternative investments.

Thirdly, we examine the impact of the exchange rate risk on performance comparisons between the emerging and the developed market investments. While other risk factors such as liquidity risk, economic policy risk and market reforms may affect both domestic and international investors significantly, currency risk is unique in the sense that it affects the return and volatility of international investor's holding instantly. The need for currency risk management is heightened after the 1994 Mexico and the 1997 Asia currency crises. An interaction between the exchange rate and the equity price markets can be seen as a measure of financial market development. Using an equilibrium model for exchange rate, stock price and capital flows with incomplete foreign exchange risk trading, Hau and Rey (2005) show that higher returns in the home equity market relative to the foreign market are associated with home currency depreciation. Generalizing this finding, we expect that after combining stock return and exchange rate movements, all the investments from both markets should offer the same level of return, providing that they have the same level of risk. As Solnik and McLeavey (2003) point out, setting aside consideration of portfolio diversification, the reaction of asset prices to fluctuations in currency values is a matter of prime concern for international investors. A major question is whether stocks and bonds provide a hedge against exchange rate movement. If the answer is not, then additional measures need to be taken to manage exchange rate risk for international investment.

Using the developed and the emerging market indices constructed by *Morgan Stanley Capital International* over 1988-2007, we investigate the relative performance of both markets' investments over a sequence of investment horizon, namely, 3-month, 6-month, 1-year and 5-year. We find that emerging market investments dominate developed market investments for investment horizon greater than 6 months, only when return are denominate in local currency, i.e., without considering currency risks. This is consistent with the nature of emerging markets as they often has a relatively higher growth rate. On the other hand, once the stock market indices are measured in the US dollar and thus the currency risk is explicitly accommodated, there is no longer evidence in favor of any dominance between the two markets for any investment horizon. This finding clearly demonstrates that the currency risk should be an important factor in the global market environment, especially from the international investors' point of view. This finding supports a view that the emerging and the developed markets are integrated both in short- and the long-term once the currency risk factor is fully taken into account.

We further investigate the effect of currency risk in emerging market investments and find that investments denominated in local currency dominate those in US dollar only for longer term investment (one year plus) but not for shorter term (up to 6 months). This result suggests that currency risk is only relevant for longer term investment in emerging market. The indifference of short-term investments indicates there is no need for hedging the currency risk for in the short investment horizon. However, the discrepancy in the utility obtained from the long-term investment indicates the need of long-term hedging instruments for currency risk in emerging market. On the other hand, we find that there is no dominance between developed market investments denominated in local currency and in US dollar. It suggests that foreign exchange risk induced by the change of exchange rate between the local currency and US dollar is reflected in the stock market movement. Investing in developed markets prove hedge against currency movement between local currency and US dollar. In other words, hedging for currency risk would not increase utility gains from US investors point of view.

We also conduct the sub-period analysis over 1988-1996 and 1999-2007, respectively, taking out the 1997 Asia Crisis period, and find that emerging market investments dominate developed counterparts in the long-run (5-year) even when they are denominated in US dollar. Combining with the whole period results, we may reach to a profound yet obvious conclusion that a huge financial crisis such as the Asian currency crisis is the key risk factor in weakening the attractiveness of emerging market investments. If such crisis would be avoided, emerging market investment were to be more preferable. But, there should be a non-negligible probability that emerging markets undergo such a crisis, given the unstable and immature nature of emerging markets. We argue that the investors should factor this risk into their emerging market investment decisions and the international financial market is efficient only when such risk factors are priced appropriately. In this regard, such risk factor can be reflected only in the full-period analysis and thus the longer full-period analysis is more preferable in order to better characterize the evolving dynamic nature of the emerging markets. Furthermore, we find evidence that emerging markets become more integrated to the global market, a finding consistent with e.g. Bekaert and Harvey (1995).

The plan of the paper is organized as follows. Section 2 briefly reviews finance studies related to emerging market investments. Section 3 introduces a spatial time series analysis and provides a new testing procedure based on the spatial dominance. Section 4 describes data and applies the spatial dominance test to both the emerging and the developed stock market returns accumulated over a sequence of different investment horizons. Section 5 provides concluding remarks.

2 Emerging Market Finance

2.1 Emerging Market Investments

A large and growing body of literature on emerging market investment has documented at least four distinguishing features of emerging market returns from developed ones: (i) higher average returns, (ii) low correlations with developed market returns, (iii) more predictable returns, and (iv) higher volatility. A higher expected return and a higher risk in emerging stock markets are well supported by both theory and empirical findings. For example, Kohers et al. (2006) find that the risk measured by standard deviation of return and the overall risk score taking account of country's economic, fiscal, legal, and governmental environment are higher in emerging stock markets for most periods over 1998-2003, whilst their returns are also higher for most time periods. The higher volatility in emerging stock markets is also supported by the number of other studies, e.g. Bekaert and Harvey (1997), Bekaert et al. (1997), DeSantis and Imrohoroglu (1997), Kawakatsu

(1999). This evidence may indicate that risk-averse investors have been compensated for assuming the higher risks associated with emerging markets investments.

The common risk factors, affecting higher expected return and higher volatility in emerging markets, include currency risk, political risk, economic risk, financial risk, capital market reforms and so on. Aggarwal et al. (1999) argue that most events causing large shift in the volatility tend to be local. Onder and Simga-Mugan (2006) report that political and economic news influence both volatility of returns and trading volume in emerging stock markets. There are also a number studies finding that average return will decrease after financial liberalizations (Henry, 2000). Bekaert and Harvey (2000) argue that the cost of capital always decreases after a capital market liberalization, which causes the equity capital to flow to emerging stock markets. We also expect that the gradual development and diversification of the market should lead to lower volatility in the long run. The presence of decreasing average return and unconditional volatility make comparisons on return inconsistent with risk return trade-off. To address this issue, a general testing framework that depends only on primitive assumptions is needed.

There has been two main stream of the literature in studying emerging market investments. One stream focuses on examining diversification benefits from exposure to emerging markets. The most often used test are mean-variance tests where a set of asset returns is said to provide diversification benefits relative to a set of benchmark returns if adding these returns to the benchmark leads to a significant leftward shift in the mean-standard deviation frontier (Bekaert and Urias, 1996). Early studies by Harvey (1994a,b) find that adding emerging market investments to a well-diversified portfolio reduces overall volatility even though the emerging-market equities are much more volatile than the industrial-market equities, but critically argue that investors require information in addition to the mean and variance of the portfolio before making their decisions.

Another stream aims to examine the risk-return relationship in the context of asset pricing model (Harvey, 1995; Dumas and Solinik, 1995), though success of these asset pricing models in uncovering the risk-return relationship is contingent on the specific model specification. For example, CAPM assumes that all investors are single-period expected utility-of-terminal-wealth maximzers and there is no restriction on the limit of this period as long as it is identical for all investments. Levhari and Levy (1977) demonstrate that if the assumption of the holding period is different from the true horizon, then there will be a systematic bias of the performance measure as well as the beta estimate. Little or no sensitivity is found between emerging market returns and traditional measures of risk such as world stock return, exchange rate investment index, oil price, and the growth in OECD industrial production and inflation (Minjoo: do you know which reference is this conclusion getting from?). Furthermore, as pointed out by Roll (1997), testing the CAPM is equivalent to testing the mean-variance efficiency of the portfolio only. It is, therefore, unlikely that any asset pricing model (that assumes complete integration of capital markets) will be able to fully account for the behavior of emerging equity markets. To this end an extended asset pricing model has also been proposed. Focusing on the time varying nature of the development in emerging market, Harvey (1995) proposes a conditional CAMP test, where conditioning is set by both common global variable and country-specific variables, and find that emerging market return is strongly influenced by local information. Furthermore, when a model allows all of the moments to change through time, there is some evidence of time-varying risk exposures. However, the conditional asset pricing models fail to price the emerging market assets correctly and to account for the time variation in expected return (see, e.g., Bekaert et al. (2007)).

Bekaert et al. (1997)point out that most empirical findings on the relative performance based on the (conventional) mean-variance and the asset pricing modelling approach should be interpreted with extreme care, since the associated performance evaluation is inappropriate in the case where the return distribution is non-normal and time varying and/or where investors' utility functions are not quadratic. Importantly, there is compelling evidence that almost all emerging market returns depart from normality (see, e.g., Harvey (1995) and Claessens et al. (1995)). Salomonsa and Grootveldb (2003) find that equity risk premium in emerging market is significantly higher than in developed markets, and suggest that investors focus more on downside risk instead of standard deviations, since the distribution of equity risk premium in emerging market is neither normal nor symmetrical.

Given the non-normal and time varying nature of stock return distribution and that almost all prior studies employ either mean-variance or asset pricing models to assess the overall performance of emerging market investment (Disyatat (2001) and Bekaert and Harvey (2003)) we propose to follow an alternative approach based on the stochastic dominance test that offers superior criteria for comparing relative performance of investments.

2.2 Market integration and the Effect of Exchange Rate Risk

Although several anomalous findings have been routinely reported in both developed and emerging market studies, most of them come to conclude that markets will be efficient once transaction costs are considered appropriately. In general developed markets are found to be more efficient than developing markets. On a global scale, an international market efficiency is often addressed in terms of the international market integration or segmentation, e.g. Solnik and McLeavey (2003). There are two different views. First, a research group with ex ante operational view highlights an importance of analyzing the role of the market openness and the impediments to capital mobility such as legal restrictions, transaction costs, political risk and currency risk. Second, an international asset pricing model investigate whether securities with similar level of risks are priced in the same manner on different markets, e.g. Bekaert and Harvey (2003).

An international efficient equity market requires that the real prices of (consumption) goods should be equalized, namely the purchasing power parity holds. If so, it does not matter whether one invests in domestic or foreign currency since the real foreign exchange risk would not exist. When the market is less than perfectly integrated, however, currency risk premium matters. Dumas and Solinik (1995) find a evidence that significant currency risk premium exists and reject a model that excludes currency risk factors. DeSantis and Imrohoroglu (1997) also find a strong support for an ICAPM that includes both market and currency risks. Hence we will examine the effect of exchange rates risk in emerging market investments by comparing the utility obtained from investments denominated in domestic currency and in US dollar. Effectively, this is tantamount to studying whether the additional risk and return accrued from foreign exchange rates will increase or decease the utility of an investor investing in emerging markets.

3 Methodology: Spatial Dominance Test

In this section, we briefly present the stochastic dominance theory which lead to the introduction of spatial dominance theory. We then present the details of the testing procedure for SPD analysis. The details of the subsampling analysis is given in the Appendix I.

3.1 Spatial Dominance Theory

Investors maximize their expected sum of utilities obtained from their investments in international stock markets by rebalancing their portfolios for a given investment horizon. The investment and rebalancing decision can be seen as a dynamic utility maximization problem. In particular, we aim to study in which stock market, developed or emerging, international investors will derive higher level of utility from their respective investment over a given planed investment horizon. Our study focuses on comparing investor's expected sum of utilities in emerging and developed stock markets over a certain period of time rather than at a given fixed time point. Considering that the returns to these investments are likely to have time varying distribution and/or to be nonstationary, the stochastic dominance approach based on the stationary distribution may be inappropriate and result in misleading results. In this regard, it is necessary to extend the static stochastic dominance approach into a dynamic one. In this paper we follow the spatial analysis of time series recently advanced by Park (2007) and propose the spatial dominance approach. This generalizes the stochastic dominance approach in a dynamic and nonstationary setting and can be more reliably used to rank investment strategies that need to be evaluated over a certain period of time.

We consider two alternative investment strategies over a certain holding period and denote the cumulative stock returns of emerging and developed markets respectively by X_t and Y_t. In order to evaluate their relative performance, we need to compare the expected sum of utilities obtained from investments in each market, namely,

$$\mathbb{E}\int_0^T u\left(X_t\right)dt \lesseqgtr \mathbb{E}\int_0^T u\left(Y_t\right)dt, \tag{1}$$

where T is an investment horizon and $u\left(\cdot\right)$ is an admissible utility function $u \in U$, where U is the set of all non-decreasing functions. We argue that this is a very generous issue involving expected returns and market-specific and global risk factors in a dynamic optimization setting.

Stochastic dominance theory provides a general framework for studying economic and financial behavior under uncertainty. Hadar and Russell (1969), Hanoch and Levy (1969), Rothschild and Stiglitz (1970) and Whitmore (1970) advance the foundations of stochastic dominance analysis. Since stochastic dominance makes decision at the view of utility comparison, it is a efficiency analysis of choices involving risk. Stochastic dominance is an optimal selection rule when all individuals' utility functions are assumed to be of a given general class of admissible functions. Hence, stochastic dominance rules are more general than the conventional mean-variance analysis and asset pricing models, which is valid only if asset returns follow a normal distribution and/or utility functions are quadratic. We introduce the definition of stochastic dominance formally as follows:

Dominance Given two risky assets X and Y with the respective cumulative distribution functions, Π_X and Π_Y, "X (stochastically) dominates Y if $\mathbb{E}u(X) \geq \mathbb{E}u(Y)$ for every admissible utility function, $u \in U$, where U is the class of all non-decreasing functions which are assumed to have finite values for any finite value of x.
First Order Stochastic Dominance (FSD) *X first order stochastic dominates Y* if and only if either $\Pi_X(x) \leq \Pi_Y(x)$ for all $x \in \mathbb{R}$ or $\mathbb{E}u(X) \geq \mathbb{E}u(Y)$ for all u, where u is non-decreasing utility function ($u' \geq 0$).
Second Order Stochastic Dominance (SSD) *X second order stochastic dominates Y* if and only if either $\int_{-\infty}^{x}\Pi_X(s)ds \leq \int_{-\infty}^{x}\Pi_Y(s)ds$ for all $x \in \mathbb{R}$, or $\mathbb{E}u(X) \geq \mathbb{E}u(Y)$ for all u, where u is non-decreasing ($u' \geq 0$) and strictly concave ($u'' \leq 0$).
Third Order Stochastic Dominance (TSD) *X third order stochastic dominates Y* if and only if either $\int_{-\infty}^{x}\int_{-\infty}^{t}\Pi_X(s)dsdt \leq \int_{-\infty}^{x}\int_{-\infty}^{t}\Pi_Y(s)dsdt$ for all $x \in \mathbb{R}$, or $\mathbb{E}u(X) \geq \mathbb{E}u(Y)$ for all u, where u is non-decreasing ($u' \geq 0$), strictly concave ($u'' \leq 0$), and preferable for positive skewness ($u''' \geq 0$).

FSD imposes a highly stringent condition, and thus its applicability is likely to be limited in most financial application involving the risky asset choices. SSD allow for investors' risk aversion and TSD for investors' positive skewness preference. These weaker concepts provide better utility interpretations as these classes of agents increasingly prefers either less risky and/or positively skewed returns as they are prepared to trade-off lower average returns for the chance of obtaining extremely certain and/or positive returns.

Several testing procedures for stochastic dominance have been proposed in the literature. An early test for stochastic dominance was advanced by McFadden (1989), which is a Kolmogorov–Smirnov (KS) type test for first- and the second-order stochastic dominance for independent samples with equal number of observations. Barrett and Donald (2003) generalize and develop KS tests for stochastic dominance of any pre-specified order and of independent samples with different number of observations. However, the asymptotic null distribution of the KS tests depends on the unknown distributions, and therefore Monte Carlo permutation procedure or simulation method are proposed to compute the associated critical values. Linton et al. (2005) propose a subsampling scheme for evaluating the critical values of the extended KS tests of Stochastic Dominance of an arbitrary order in the general K-prospect case, also allowing for the observations to be dependent and for the prospects ranked to be of general dependence using full-sample. (Minjoo:Why don't we reference Post 2005)[3]

However, the stochastic dominance approach is not appropriate to solve economics and finance problems in which the time series of interest do not have time invariant distributions, since it only allows us to assess the expected utilities either at a given fixed time in a completely static setting or under the assumption of strict stationarity. To overcome this important issue we follow the *spatial analysis of time series* recently developed by Park (2007). The spatial analysis is developed primarily for the time series that are nonstationary, i.e., the time series that do not have time invariant distributions. Unlike the time invariant distribution that exists only under stationarity, the spatial distribution is well defined for both nonstationary and stationary time series. In fact, the spatial distribution approach allows us to extend various models that have been developed under the presumption of stationarity, and make them applicable for nonstationary time series as well. For nonstationary time series, the spatial distribution may be interpreted as the aggregate of its time-varying distribution over a period of time. Therefore, the sum of the expected utilities generated by a stochastic process is determined solely by its spatial distribution (Park, 2007).

We now briefly review the spatial analysis of time series analysis,[4] which is built upon an empirical assessment of the expected value of the local time of the underlying stochastic process that generates the observed time series. Local time, denoted $\ell\,(T, x)$, represents the frequency at which the stochastic process $X = (X_t)$ visits the spatial point x up to the time T. The local time itself is a stochastic process. The expectation of local time then becomes the *spatial density* $\lambda\,(T, x)$ which represents the expected frequency at which the

[3]Alternatively, Davidson and Duclos (2000) propose a testing procedure which compares cumulative distribution functions over an arbitrary grid of points so that their test can be applied to dependent samples.

[4]See Park (2007); Bosq (1997); Revuz and Yor (1994) for further details.

underlying stochastic process visits each spatial point. Similarly, the *spatial distribution* $\Lambda(T, x)$ is given by the expectation of the integrated local time [5].

An evaluation of the expected sum of utilities in the stochastic dynamic optimization problem, is very complicated, but this problem can be easily solved by spatial analysis since the expected sum of utilities generated by a stochastic process over a period of time can be derived from its spatial distribution by construction, as easily seen by[6] (This sentence need to be rewrite.)

$$\mathbb{E} \int_0^T u(X_t)dt = \int_{-\infty}^{\infty} u(x)\lambda(T, x)dx. \tag{2}$$

Therefore, we are now able to extend the static stochastic dominance to spatial dominance as a general concept, which can also be applied to nonstationary time series as well.

Formally we define the first, the second and the third order spatial dominance as follows.

First Order Spatial Dominance (FSPD) X *first order spatial dominates* Y if and only if either $\Lambda_X^{(0)}(T, x) \leq \Lambda_Y^{(0)}(T, x)$ for all $x \in \mathbb{R}$, or $\mathbb{E}\int_0^T u(X_t)\,dt \geq \mathbb{E}\int_0^T u(Y_t)\,dt$ for all u, where u is a non-decreasing utility function ($u' \geq 0$) and $\Lambda_{\cdot}^{(0)}(T, x) = \Lambda_{\cdot}(T, x)$ is a spatial distribution function.
Second Order Spatial Dominance (SSDP) X *second order spatial dominates* Y if and only if either $\Lambda_X^{(1)}(T, x) \leq \Lambda_Y^{(1)}(T, x)$ for all $x \in \mathbb{R}$, where $\Lambda_{\cdot}^{(1)}(T, x) = \int_{-\infty}^{x} \Lambda_{\cdot}(T, s)\,ds$ is an integrated spatial distribution function, or $\mathbb{E}\int_0^T u(X_t)dt \geq \mathbb{E}\int_0^T u(Y_t)dt$ for all u, where u is non-decreasing ($u' \geq 0$) and strictly concave ($u'' \leq 0$).
Third Order Spatial Dominance (TSPD) X *third order spatial dominates* Y if and only if either $\Lambda_X^{(2)}(T, x) \leq \Lambda_Y^{(2)}(T, x)$ for all x, where $\Lambda_{\cdot}^{(2)}(T, x) = \int_{-\infty}^{x}\int_{-\infty}^{t} \Lambda_{\cdot}(T, s)dsdt$ is an double-integrated spatial distribution function, or $\mathbb{E}\int_0^T e^{-rt}u(X_t)dt \geq \mathbb{E}\int_0^T e^{-rt}u(Y_t)dt$ for all u, where u is nod-decreasing ($u' \geq 0$), strictly concave ($u'' \leq 0$), and preferable for positive skewness ($u''' \geq 0$).

3.2 Testing for Spatial Dominance

To test the validity of FSPD, SSPD and TSPD, we set the null hypotheses (X *s-order spatial dominates* Y) against the alternative hypothesis (X *does not s-order spatial dominate*

[5]A spatial density and a spatial distribution are defined by $\lambda(T, x) = \lim_{\epsilon \to 0} \frac{1}{2\epsilon}\int_0^T \mathbb{P}\{|X_t - x| < \epsilon\}\,dt$ and $\Lambda(T, x) = \int_0^T \mathbb{P}\{X_t \leq x\}\,dt$ and they will provide whole distributional information for the underlying stochastic process, which are either stationary or nonstationary. The spatial density and distribution will trivially become the time invariant density and distribution function under stationarity.

[6]See Lemma 2.1 in Park (2007).

Y):

$$H_0^{(s)} : \Lambda_X^{(s-1)}(T,x) \leq \Lambda_Y^{(s-1)}(T,x) \text{ for all } x \in \mathbb{R},\ s = 1,2,3, \tag{3}$$

$$H_1^{(s)} : \Lambda_X^{(s-1)}(T,x) > \Lambda_Y^{(s-1)}(T,x) \text{ for some } x \in \mathbb{R},\ s = 1,2,3, \tag{4}$$

where $\Lambda_{\cdot}^{(s-1)}(T,\cdot)$ is the $(s-1)$-order integrated spatial distribution function defined above. Then, the test statistics are derived by comparing the Kolmogorov-Smirnov uniform distance between the respective estimated $(s-1)$ integrated spatial distribution functions of X and Y as:

$$D_N^{(s)}(T) = \sqrt{N} \sup_{x\in\mathbb{R}} \left[\hat{\Lambda}_X^{(s-1)}(T,x) - \hat{\Lambda}_Y^{(s-1)}(T,x)\right],\ s = 1,2,3, \tag{5}$$

where $\hat{\Lambda}_{\cdot}^{(s)}(T,x)$ is the consistent estimator of $\Lambda_{\cdot}^{(s)}(T,x)$.[7]

However, the limit distributions of the $D_N^{(s)}(T)$ statistics are dependent upon the (generally unknown) probability law of the underlying stochastic processes, X and Y in quite a complicated manner. In general, the subsampling scheme, which we adopt in this paper, appears to be most readily available to obtain the limit distributions of $D_N^{(s)}(T)$, see Linton et al. (2005) for stochastic dominance and Park (2007) for spatial dominance.

We now describe how to apply the Spatial Dominance test procedure to assess the performance of Emerging stock market investments relative to Developed counterparts in details. To this end we assume that both (X_t) and (Y_t) are stochastic processes with stationary independent increments which is assumed to be strictly stationary and α-mixing. Under this assumption, we set the following sequence of the null hypotheses for $s = 1,2,3$,

$$H_{0,XY}^{(s)} : X \nsim Y,\ H_{0,X}^{(s)} : X \succ_{(s)} Y,\ H_{0,Y}^{(s)} : Y \succ_{(s)} X,$$

where $\nsim$ stands for the existence of an *sth order spatial dominance and* $\succ_{(s)}$ for an *sth order spatial dominance* in favor of the former stochastic process under the null.[8] The validity of $H_{0,X}^{(s)}$ and $H_{0,Y}^{(s)}$ can be tested by comparing the Kolmogorov-Smirnov uniform distance between the estimated spatial distribution functions of X and Y respectively for $s = 1,2,3$ as:

$$D_{N,X}^{(s)} = \sqrt{N} \sup_{x\in\mathbb{R}} \left[\hat{\Lambda}_{N,X}^{(s-1)}(T,x) - \hat{\Lambda}_{N,Y}^{(s-1)}(T,x)\right], \tag{6}$$

$$D_{N,Y}^{(s)} = \sqrt{N} \sup_{x\in\mathbb{R}} \left[\hat{\Lambda}_{N,Y}^{(s-1)}(T,x) - \hat{\Lambda}_{N,X}^{(s-1)}(T,x)\right], \tag{7}$$

where $\hat{\Lambda}_{N,X}^{(s-1)}(T,x)$ and $\hat{\Lambda}_{N,Y}^{(s-1)}(T,x)$ are the estimates of the $(s-1)$-order integrated spatial

[7]As $N \to \infty$, Park (2007) shows that $D_N^{(s)}(T) \underset{d}{\to} \sup_{x\in\mathbb{R}} \left[U_X^{(s-1)}(T,x) - U_Y^{(s-1)}(T,x)\right]$ for $s = 1,2,3$, where $U_{\cdot}^{(0)}(T,\cdot)$ is a zero mean Gaussian process with finite covariance kernel, $U_{\cdot}^{(1)}(T,x) = \int_{-\infty}^{x} U_{\cdot}^{(0)}(T,s)ds$, and $U_{\cdot}^{(2)}(T,x) = \int_{-\infty}^{x}\int_{-\infty}^{t} U_{\cdot}^{(0)}(T,s)dsdt$.

[8]McFadden (1989) proposes to consider $H_{0,XY}^{(s)}$ prior to testing $H_{0,X}^{(s)}$ and $H_{0,Y}^{(s)}$ to avoid any ambiguity.

distribution functions of X and Y, obtained by

$$\hat{\Lambda}_{N,X}^{(s-1)}(T,x) = \frac{1}{N}\frac{\delta}{(s-1)!}\sum_{i=1}^{N}\sum_{j=1}^{p}(x-X_{i,j\delta})^{s-1}1\{X_{i,j\delta}\leq x\},$$

$$\hat{\Lambda}_{N,Y}^{(s-1)}(T,x) = \frac{1}{N}\frac{\delta}{(s-1)!}\sum_{i=1}^{N}\sum_{j=1}^{p}(x-Y_{i,j\delta})^{s-1}1\{Y_{i,j\delta}\leq x\}, \quad (8)$$

where $p = T/\delta$ is a total number of observations in the holding period, the sample observation inside the ith holding period is denoted by $X_{i,\cdot} = \{X_{i,1\delta}, ..., X_{i,p\delta}\}$ and $1\{\cdot\}$ is an indicator function.[9] Finally, the validity of $H_{0,XY}^{(s)}$ can be tested by the MacFadden test statistic:

$$M_N^{(s)} = \min\left(D_{N,X}^{(s)}, D_{N,Y}^{(s)}\right), \; s = 1, 2, 3. \quad (9)$$

In principle, the spatial dominance test should be carried out sequentially as follows: First, begin with testing the null hypotheses, $H_{0,XY}^{(1)}$, $H_{0,X}^{(1)}$ and $H_{0,Y}^{(1)}$. If $H_{0,XY}^{(1)}$ and $H_{0,X}^{(1)}$ are not rejected but $H_{0,Y}^{(1)}$ is rejected, then we conclude that *the emerging market investment first-order spatial dominates the developed one.* On the other hand, if $H_{0,XY}^{(1)}$ and $H_{0,Y}^{(1)}$ are not rejected but $H_{0,X}^{(1)}$ is rejected, then we conclude that *the emerging market investment is first-order spatially dominated by the developed one.* Otherwise, *there is no first-order spatial dominance* and continue to test the null hypotheses for 2-order dominance: $H_{0,XY}^{(2)}$, $H_{0,X}^{(2)}$ and $H_{0,Y}^{(2)}$. If $H_{0,XY}^{(2)}$ and $H_{0,X}^{(2)}$ are not rejected but $H_{0,Y}^{(2)}$ is rejected, then we conclude that *the emerging market investment second-order spatial dominates the developed one.* On the other hand, if $H_{0,XY}^{(2)}$ and $H_{0,Y}^{(2)}$ are not rejected but $H_{0,X}^{(2)}$ is rejected, then we conclude that *the emerging market investment is second-order spatially dominated by the developed one.* Otherwise, *there is no second-order spatial dominance*, continue to test the null hypotheses for 3-order dominance, $H_{0,XY}^{(3)}$, $H_{0,X}^{(3)}$ and $H_{0,Y}^{(3)}$, and repeat the same inference as above.

As discussed earlier, the asymptotic null distributions of the $D_{N,\cdot}^{(s)}(T)$ and $M_N^{(s)}$ tests depend on the unknown population distributions. We therefore follow Linton et al. (2005) and Park (2007), and employ a subsampling scheme for evaluating the critical values of the spatial dominance tests derived above.[10] We describe the practical subsample scheme in the Appendix I.

In next section we will apply the spatial dominance tests to the emerging and developed stock market returns accumulated over a sequence of different investment horizons and assess their relative performance. To explicitly deal with the general nature of the current

[9]Notice in empirical applications that we normalize $T = 1$, and set p to the number of days in the holding period, e.g. $p = 126$ for 6-month holding period.

[10]Linton et al. (2005) propose non-parametric tests of stochastic dominance by extending the Kolmogorov-Smirnov type statistics developed by McFadden (1989) and suggest a subsampling bootstrap method to evaluate the critical values and the associated p-values. See also Linton et al. (2005) for an application.

dynamic decision making problem, we should employ the discounted local time, or simply d-local time, ℓ^r of the stochastic process.[11]

4 Empirical Application to Spatial Dominance between Emerging and Developed Stock Market Investments

We aim to compare the expected sum of utilities obtained from investments in each market in a dynamic setting. We consider investment with 3 months, 6 months, 1 year and 5 years holding periods. The cumulative returns for emerging and developed stock markets, denoted by X_i and Y_i, are constructed by

$$X_i = \sum_{j=1}^{p} r^E_{j+(i-1)s},\ Y_i = \sum_{j=1}^{p} r^D_{j+(i-1)s},\ i = 1, 2, ..., N,$$

where $r^E_\cdot$, $r^D_\cdot$ are daily stock return for emerging and developed markets, p is a number of observations over the given investment holding period, $N = \left[\frac{T^*-p}{s}\right] + 1$ is a total number of observations of the returns accumulated over a given investment horizon, T^* is the total number of the full sample observation, $[\cdot]$ denotes the largest integer part of the argument, and s is a size of moving step allowing for overlapping. So we have $p = 63$, 126, 252, and 1260 for 3-month, 6-month, 1-year and 5-year investment horizons, respectively.

To examine the effect of the exchange rates risk on a performance comparison, we consider the emerging and the developed market stock returns measured in the local currency and in the US dollar. Furthermore, in order to examine the effect of 1997 currency crisis on the performance comparison, we split the sample into two sub-periods (1988-1998 and 1999-2007) and repeat the performance evaluation.

4.1 Data

This research uses developed and emerging market (investable) indices reported by *Morgan Stanley Capital International* (MSCI). They are based on individual MSCI country indices. Individual MSCI country indices are aggregated into composite indices. Market capitalization weighting and consistent 60% target inclusion of each market ensure that each country's weight in the regional and the composite indices is proportional to its weight in the total. As of June 2006, the MSCI Emerging Markets Index consists of the following 25 emerging market country indices: Argentina, Brazil, Chile, China, Colombia, Czech

[11] d-local time is defined as (see Park (2007) for more details) $\ell^r(T,x) = \int_0^T e^{-rt}\ell(dt,x)$ for some discount rate $r > 0$. Obviously, the d-spatial distribution function of X is defined accordingly by $\Lambda^r(T,x) = \int_0^T e^{-rt}\mathbb{P}\{X_t \leq x\}\,dt$. Hence, in what follows, we provide all the spatial dominance test results based on the d-spatial distribution function, $\Lambda^r(T,x)$.

Republic, Egypt, Hungary, India, Indonesia, Israel, Jordan, Korea, Malaysia, Mexico, Morocco, Pakistan, Peru, Philippines, Poland, Russia, South Africa, Taiwan, Thailand, and Turkey, whilst the MSCI Developed Markets Index consists of the following 23 developed country indices: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hong Kong, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, the United Kingdom and the United States. These MSCI indices, as accepted the standards by global portfolio managers, are regarded as performance measurement benchmarks of global stock markets. Both indices are collected from 4/Jan/1988 to 7/May/2007 (a total of 5,046 observations). Further to investigate the currency risk effect, we use indices measured respectively in the local currency and in the US dollar.

Tables 1, 2 and 3 present the descriptive statistics results (the number of observations, mean, standard deviation, skewness, excess kurtosis, minimum, median, maximum and the Jarque-Bera test statistic for normality) for the emerging and the developed market daily stock returns, and cumulative returns over 3-month (63 days), 6-month (126 days), 1-year (252 days) and 5-year (1260 days) holding periods in both local currency and US dollar over the whole sample period (1988-2007) and the sub-periods (1988-1996 and 1999-2007). The daily returns is computed as the log difference of the respective stock price indices, and the cumulative returns are constructed allowing an overlapping with 5-day moving-step.[12]

We first consider the full sample period (see Table 1). Consistent with the previous literature, there are several stylize facts about emerging market investments. Comparing the emerging and the developed market stock returns measured in the local currency over the full sample, we find that emerging market investments have higher returns (about 4-5 times) and higher volatility (about 2-3 times). Similar patterns are found in comparing returns measured in US dollar but in much smaller magnitudes.

Comparing the same market returns denominated in local currency and in US dollar, the emerging market returns denominated in the local currency is higher than those denominated in US dollar whilst the opposite is true for the developed market. This suggests that the emerging market currency has been depreciated against US dollar while the developed market currency has been appreciated against US dollar over the whole sample period. Interestingly, we find that the volatility of the emerging market investment returns decrease rather than increase when taking currency exchange into consideration. Overall, the basic statistics suggest that there are higher risk and higher return for the emerging market investments.

Table 1 about here

[12]We have also attempted to construct both cumulative returns using an overlapping with 21-day moving-step. The results in what follow are qualitatively similar. The detailed estimation and test results will be available upon request.

Examining the higher moments of the data, somewhat a clear pattern emerges. Although normality in the return distribution is rejected for almost all investment horizons, the extent of the violation decreases as an investment horizon increases. The kurtosis and the Jarque-Bera test statistic decrease as the investment horizon increases from 1 day to 5 year, which is consistent with a finding by Aggarwal and Aggarwal (1993).

Figures 1 and 2 provide the time series plots of the daily returns and the returns accumulated over 3-month, 6-month, 1-year and 5-year holding periods of both emerging and developed markets. A careful investigation of the figures clearly suggests different market movements for different periods. The discrepancy is more visible in the cumulative returns of emerging market. First, both the short- and the long-term emerging market returns are significantly higher than the developed counterparts but continue to decrease during the first sub-period whilst they are much smaller but tend to increase during the second sub-period. Second, there is a sizable (positive) gap between the emerging market returns measured in the local currency and in the US dollar in the first sub-period, while the gap gets narrower and then its sign reverses sometimes in the second sub-period. Emerging markets have indeed undergone many political, economic and financial events locally and globally such as capital market liberalizations, currency and financial crises. In this regard we may consider that emerging market has been more or less segmented and unstable in the first sub-period and become more or less integrated in the second sub-period. Interestingly, we also observe that most local currencies in emerging markets have been depreciated or devalued against the US dollar during the first sub-period, whereas the currency movements have been reversed during the second sub-period.

Figures 1 and 2 about here

Next, we summarize the descriptive statistics results for two sub-periods excluding the 1997 Asian crisis period during 1997-98 in Tables 2 and 3. Looking at the daily returns measured in the local currency over the first subperiod, the emerging market daily stock returns are much higher on average, slightly more volatile, slightly negatively skewed and of negligibly fatter tails as compared to the developed counterparts. As in the full sample period, there is a trade-off between higher average return (but the difference is far more significant) and more downward-skewness. On the other hand, the daily returns denominated in the local currency over the second subperiod show a similar patten as above but at a smaller scale. Overall the return distributions over the sub-periods are somewhat similar to those observed over the whole period, though the effect of currency fluctuation on emerging market returns seems to be much moderate in the post-crisis period.

Tables 2 and 3 about here

4.2 Spatial dominance between emerging and developed market performance

We study the dominance between emerging and developed market performance in this section. The stochastic and spatial dominance test results can be interpreted from two different points of view. First, from an individual investor's point of view, that investment in asset A dominates investment in asset B, will indicate a (possible) utility gain if he/she switches investment from B to A. Second, from a market integration and market efficiency point of view, such dominance can be regarded as an indication of market inefficient under all regularity conditions. This is so because if random asset A dominates random asset B, rational investors will take a switch from B to A, and thus the less preferable investment in B would be either driven out of market or its return will improve until dominance disappears.

4.2.1 Full sample period (1988-2007)

Returns denominated in the local currency This section studies the performance of the investment-returns in both emerging and developed markets denominated in their local currencies. Since they involve no currency-risk, we take the view point of domestic investors who do not diversify their investments internationally. This situation occurs due to several barriers to international investments and home biases constraints.

Table 4 reports the stochastic and spatial dominance test results. SD and SPD stand for the stochastic and spatial dominance tests developed in Section 3. We use the sub-sampling approach and obtain the critical values of both statistics for the sub-sample sizes ranging between $N^{0.7}$ and $N^{0.9}$ with a total of 31 grids. We then select the empirical median values as the critical values in inference. X and Y indicate the emerging and the developed stock market returns accumulated over the given holding period. $X \nsim_s Y$ implies that there exists s-order (stochastic or spatial) dominance rank between X and Y for $s = 1, 2, 3$. $X \succ_s Y$ implies that X s-order (stochastically or spatially) dominates Y for $s = 1, 2, 3$. $Y \succ_s X$ implies that Y s-order (stochastically or spatially) dominates X for $s = 1, 2, 3$. *, ** and *** indicate a rejection of the null at 10, 5 and 1%, respectively. X is said to dominance Y only if neither $X \nsim_s Y$ nor $X \nsim_s Y$ is rejected and vice verse.

Table 4 panel A reports the results for using local currency index. Without considering currency risk, our SPD results suggest that emerging market investments first order dominate developed market investments in investment horizon greater than 6 months whereas it is indifferent to investing in emerging and developed markets in the shorter-term (up to 6 month). This is consistent with the nature of emerging market that a market is emerging as they have faster growth and will be eventually emerged out as a developed market (Chapter 9 in Solnik and McLeavey, 2003). This finding suggests that the longer-term (one- to five-year horizon) investment should be held before the local investors will substantially benefit from the emerging market growths. Our findings in the SPD tests are consistent for the three order tests.

For a comparison we also provide the stochastic dominance test results. These results summarized in Table 4, show that the emerging market returns first order stochastic dominates the developed ones in the short- and the long-term. There is a discrepancy between stochastic and spatial dominance test results only for the 3- and 6-month horizon. Surprisingly, however, the second- and third-order stochastic dominance test results suggests that there is no dominance in both investment horizon, and this is in conflict with the first-order result.[13]Furthermore, providing that it would be inappropriate in the current case where the cumulative returns of both markets are likely to have time-varying distributions and thus be nonstationary, we should discount these results. Hence we will focus on our discussion on the spacial dominance test results, though pointing out any inconsistency between SPD and SD results if necessary.

To examine how our proposed spatial dominance test results are robust to the subsampling size, we have evaluated the p-value of the tests for a number of different subsample sizes. Figure 4 plots the p-values across different subsample sizes of the spatial dominance tests being applied to the investment returns denominated in the local currency. For the shorter-term holding periods (3- and 6-month) the null of the first- and the second-order dominance is rejected for all subsample sizes used whilst there is very weak evidence that the null of the third-order spatial dominance is not rejected marginally only for 6-month horizon when a subsample size is less than 250**.** Turning to the longer-term holding periods, the null of the first-, the second- and the third-order spatial dominance is not rejected for the 5-year horizon whilst there is weak evidence that the null of the first- and the second-order spatial dominance is rejected marginally for 1-year horizon when a subsample size is greater than 300**.** This is clearly consistent with our test results above obtained using the median values as the critical values used in inference, as discussed in Section 3.

Figure 3 and 4 about here

Returns denominated in the US Dollar Table 4 Panel B report the results for return measured in US dollar. With the fluctuation of currency movement is explicitly accommodated we take the view point of an international investor whose base currency is US dollar. Panel B show that both spatial and stochastic dominance test results strongly indicate that there is no dominance at any order. This evidence suggests that investments

[13]Theoretically, this should not be feasible. Indeed we find that the stochastic dominance test results tend to provide inconsistent results especially for the short-term horizon investments. On the other hand, the spatial dominance test results are mostly consistent across different dominance orders. In this regard the simulation study will be desirable.

in emerging and developed market will become indifferent, once the exchange rate risk is fully taken into account.

This finding may support the market efficiency and market integration hypotheses, since it implies that the same level of risk (including the higher order risks such as skewness risk than the second order risk) will reward the same level of return for both emerging and developed market investments. The exchange rate parity condition signifies that the currency risk allowance would control for other important macro economic factors such as inflation and interest rate. Therefore, non-dominance between emerging and developed market investments may justify the existence of efficient and integrated global financial market.

Table 4 about here

Figure 6 shows the associated p-values of the spatial dominance test results across different subsample sizes. The null of the first- and the second-order dominance or non-maximality is rejected for all subsample sizes used and for all investment horizons. Though there is some evidence of the third-order dominance ($X \gtrless_3 Y$), but both hypotheses, $X \succ_3 Y$ and $Y \succ_3 X$, are not rejected either. We therefore conclude that there is no spatial dominance between X and Y. This is also consistent with our formal test results reported in Table 4.

Figure 5 and 6 about here

In summary, these findings suggest that the emerging market performance strongly dominates the developed counterpart in terms of the 1-year and 5-year holding period investment over the full sample period, 1988-2007, only when the respective investment returns of emerging and developed markets are measured in the local currency. In other words, local investors in emerging markets have enjoyed higher level of utility than those in developed markets. However, once the currency risk factor is allowed for, such dominance disappears. Therefore, our findings clearly demonstrate that both emerging and developed markets are likely to be integrated both in the short- and the long-term only when the exchange rate risk is fully taken into account.

4.2.2 Sub-period analysis

The sub period results for local currency return confirm the finding in full sample analysis. Investments in emerging market dominate those in developed market only for horizons being greater than or equal to one-year (see Table 5). In particular, the sub-period analysis shows an additional insight to the effect of the 1997 crisis, when taking into account of currency effect (see Table 6). Excluding the time period during 1997-98, emerging market investments dominate developed market investment in the long run (5-year) even when they are denominated in US dollar. Combining with the whole period results, we may reach to a profound yet obvious conclusion that a huge financial crisis such as the Asian currency crisis is the key risk factor in weakening the attractiveness of emerging market investments. If such crisis would be avoided, emerging market investment were to be more preferable. However, there should be a non-negligible probability that emerging markets undergo such a crisis, given the unstable and immature nature of emerging markets. We argue that it is important to incorporate this risk into emerging market investment decisions and longer time period is essential to accessing emerging market investment performance.

Tables 5 and 6 about here

4.3 Spatial dominance between the same market returns denominated in the local currency and the US dollar

The international investor measures total return as the sum of returns on the assets, in local currencies, plus any currency movements. The investor bears both market and foreign currency risks. The empirical findings in the last subsection clearly demonstrates the importance of currency risk in emerging market investment. In this subsection we further study the direct effect of the currency risk on investments in the same market.

4.3.1 Full sample period (1988-2007)

We first compare the utility of emerging market investments obtained respectively by domestic and international investors (see Table 7). For short-term investment horizons (3 and 6 month), emerging market investments in local currency and US dollar are indifferent whereas for the longer-term horizons (1 and 5 year), investments in local currency have higher utility than those in US dollar. From the international investors' point of view, this finding shows that the effect of the exchange rate risk will become more important for the investment horizon equal to or greater than 1-year. Therefore, effective currency hedging is only worth for investment holding period equal to or longer than 1-year. International investors is possible to enjoy same level of utility gains as domestic investors from emerging market investment only if such currency risk can be hedged with low costs.

Turing to the developed market investments we find that the utility of investments obtained in local currency and US dollar are indifferent for all investment horizon. This result indicates that the developed financial markets are is well-integrated between different asset classes and between countries. Our results suggest currency risk is irrelevant in developed market investment from investor's utility point of view. It suggests that investing in stock market could provide a hedge for currency risk since the stock market will also react to the fluctuation of currency movement and provides similar level of utility gains for both domestic and international investors.

Table 7 about here

4.3.2 Sub-period analysis

Sub-period analysis provide further evidence that emerging financial markets are yet under-developed. In the first sub-period, emerging market investments in the local currency dominate those in US dollar for all investment horizon. It strongly suggest that currency risk is a negative factor in emerging market investments during the 90s. Taking the currency risk would not be rewarded with proportional return in both short and long term investment. It also indicates that if international investor could have effective means of hedging the currency risk for their emerging market investment, they would gain higher utility by investing in emerging market in local currency.

During the second sub-period, the first-order dominance disappears. This can be seen as a sign of improved market development and integration after the 1997 currency crisis. This finding is consistent with an earlier finding by Bekaert and Harvey (1995), who provide evidence that many emerging markets were segmented in their early years but have become more integrated to the global market. However, the second-order dominance of 5 year investments in emerging market suggests that international investors are still likely to enjoy potential utility gains if the currency risk is hedged properly. Finally, the results for the developed market investments are almost the same as those obtained for the full sample.

Tables 8 and 9 about here

There are some noticeable differences between SD and SPD tests in this section. The SD test appears to be more likely to conclude a dominance relationship than for the SPD test. For example, for the full sample tests, SD tests suggest that investments in local currency dominate those in US dollar for both short and long term horizon whereas SPD tests only conclude the latter. SD tests also suggest second-order dominance of US dollar over local currency investment in developed market which is not found in SPD tests.

In summary, emerging market investments do not provide hedge against exchange rate risk. Hence, international investors need to take into account the currency risk in making their global investment mixture. Without hedging the currency risk, international investor would receive less utility from their investment in emerging market. This is especially the case for investment horizon longer that 1-year. On the other hand, for international investors who invest in developed market, it is indifferent between investing using the local currency or the US dollar except for investment horizon greater or equal to 5-year.

4.4 Spatial dominance between the same market returns before and after Asian Currency Crisis

Finally, we compare the investment performance before and after the Asian Currency Crisis and examine the possibility of market timing effect. The spatial dominance test results reported in Tables 10 and 11 clearly demonstrate that emerging market investments before the Crisis dominate those after the Crisis over all investment horizons only when the currency risk is not considered whilst such dominance is observed only over 5-year holding period when the returns are denominated in the US dollar. On the other hand, developed market investments before the Crisis dominate those after the Crisis only over 5-year holding period irrespective of currency denomination. This finding may suggest a possibility of market timing, indicating that the emerging market investment was clearly a better alternative during most of the 1990s before the crisis than after the crisis. This could be a reflection of the prolonged effect of the currency crisis on (Asian) emerging markets. Alternatively, it would imply the fact that high growth and high return of emerging market investments seen in 1990s may no longer be sustainable.

Tables 10 and 11 about here

5 Conclusions

In this paper, we study international investor's expected sum of utilities obtained from investments in emerging and developed stock markets over a certain investment horizon and compare their relative performance over, 3-month, 6-month, 1-year and 5-year holding period. Considering that the investment returns accumulated over the specified holding period are likely to have time varying distribution and/or to be nonstationary, we suggest to use a spatial dominance test which is more generally suited for analyzing dynamic and nonstationary process, instead of the stochastic dominance approach which is based on the stationary distribution assumption and which may be inappropriate in the dynamic and nonstationary case.

Applying out tests to MSCI emerging and developed market indices, we find emerging market investments strongly dominate the developed counterparts over the longer-term (1 and 5-year) holding periods over 1988-2007, only when the respective investment returns are denominated in their local currencies. On the other hand, such dominance disappears once the currency risk factor is explicitly taken into account. Our findings may suggest that both emerging and developed markets are more likely to be integrated into the global market only after the currency risk is appropriately factored into. Therefore, international investors need to explicitly take into account the currency risk in their investment. Without hedging the currency risk, international investor would receive less utility from their investment in emerging market. On the other hand, for international investors who invest in developed market, our results suggest that it is indifferent between investing in local currency or US dollar.

On immediate extension of the current study is to apply our methodology and empirically investigate any dominance relationship between the returns of international portfolios which are constructed by sorting the country returns by well-established risk factors such as demographics, market integration, persistence, size and fundamental valuation measures (see Harvey's website). This will shed further lights on enhancing our understanding as to how observable risk factors interact with investors' utility.

Appendix

To evaluate the critical values of the spatial dominance test, we first need to draw a subsample of size M (without shuffling time order).[14] This results in $N-M+1$ subsamples of size M for X and Y as follows:

$$X_{(h)} = (X_h, X_{h+1}, \ldots, X_{h+M-1}), \; Y_{(h)} = (Y_h, Y_{h+1}, \ldots, Y_{h+M-1}), \; h = 1, \ldots, N-M+1.$$

From each subsample we evaluate the (spatial dominance) test statistics and obtain the estimated (subsample) $(s-1)$ integrated spatial distributions of X and Y for $s = 1, 2, 3$ and $h = 1, \ldots, N-M+1$ by

$$\begin{aligned}
\hat{\Lambda}^{(s-1)}_{M,X_{(h)}}(T,x) &= \frac{1}{M}\frac{\delta}{(s-1)!}\sum_{i=1}^{M}\sum_{j=1}^{p}(x - X_{i+h-1,j\delta})^{s-1}\,1\{X_{i+h-1,j\delta} \leq x\}, \\
\hat{\Lambda}^{(s-1)}_{M,Y_{(h)}}(T,x) &= \frac{1}{M}\frac{\delta}{(s-1)!}\sum_{i=1}^{M}\sum_{j=1}^{p}(x - Y_{i+h-1,j\delta})^{s-1}\,1\{Y_{i+h-1,j\delta} \leq x\}. \qquad (10)
\end{aligned}$$

Then the subsample test statistics are obtained for $s = 1, 2, 3$, and $h = 1, \ldots, N-M+1$ by

$$\begin{aligned}
D^{(s)}_{M,X_{(h)}} &= \sup_{x\in\mathbb{R}} \sqrt{M}\left(\left[\hat{\Lambda}^{(s-1)}_{M,X_{(h)}}(T,x) - \hat{\Lambda}^{(s-1)}_{N,X}(T,x)\right] - \left[\hat{\Lambda}^{(s-1)}_{M,Y_{(h)}}(T,x) - \hat{\Lambda}^{(s-1)}_{N,Y}(T,x)\right]\right), \\
D^{(s)}_{M,Y_{(h)}} &= \sup_{x\in\mathbb{R}} \sqrt{M}\left(\left[\hat{\Lambda}^{(s-1)}_{M,Y_{(h)}}(T,x) - \hat{\Lambda}^{(s-1)}_{N,Y}(T,x)\right] - \left[\hat{\Lambda}^{(s-1)}_{M,X_{(h)}}(T,x) - \hat{\Lambda}^{(s-1)}_{N,X}(T,x)\right]\right), \\
M^{(s)}_{M,(h)} &= \min\left(D^{(s)}_{M,X_{(h)}}, D^{(s)}_{M,Y_{(h)}}\right), \qquad (11)
\end{aligned}$$

where $\hat{\Lambda}^{(s-1)}_{N,X}(T,x)$ and $\hat{\Lambda}^{(s-1)}_{N,X}(T,x)$ are defined in (8). The subsampling scheme is successfully justified to show that the sampling distribution of $D^{(s)}_{N,X}$, $D^{(s)}_{N,Y}$ and $M^{(s)}_{N}$ can be approximated by the sampling distribution of $D^{(s)}_{M,X_{(h)}}$, $D^{(s)}_{M,Y_{(h)}}$, and $M^{(s)}_{M,(h)}$ over $N-M+1$ different subsamples of size M. Specifically, we can approximate these sampling distributions by

$$\begin{aligned}
G^{(s)}_{M,X}(\omega) &= \frac{1}{N-M+1}\sum_{j=1}^{N-M+1} 1\left\{D^{(s)}_{M,X_{(h)}} \leq \omega\right\}, \\
G^{(s)}_{M,Y}(\omega) &= \frac{1}{N-M+1}\sum_{j=1}^{N-M+1} 1\left\{D^{(s)}_{M,Y_{(h)}} \leq \omega\right\}, \\
G^{(s)}_{M}(\omega) &= \frac{1}{N-M+1}\sum_{j=1}^{N-M+1} 1\left\{M^{(s)}_{M,(h)} \leq \omega\right\} \qquad (12)
\end{aligned}$$

[14] In small samples, we need to allow overlapping, which is inevitable to increase the number of subsampling observations.

Let $x^{(s)}_{M,(1-\alpha)}$, $y^{(s)}_{M,(1-\alpha)}$ and $m^{(s)}_{M,(1-\alpha)}$ denote the $(1-\alpha)$th sample quantile of $G^{(s)}_{M,X}$, $G^{(s)}_{M,Y}$ and $G^{(s)}_{M}$, i.e. $x^{(s)}_{M,(1-\alpha)} = \inf\left\{\omega : G^{(s)}_{M,X}\left(\omega\right) \geq 1-\alpha\right\}$. Then these will become the subsample critical values of significance level, α. To make the test procedure robust to the selected subsample size, Linton et al. (2005) suggest to select a sequence of subsample values from $\{M_1, M_2, \ldots, M_K\}$, where M_1 and M_K are lower and upper bounds, and select the median value as critical values.[15] For significance level α, we then obtain the estimated critical values, denoted $x^{(s)}_{M_k,(1-\alpha)}$, $y^{(s)}_{M_k,(1-\alpha)}$ and $m^{(s)}_{M_k,(1-\alpha)}$, $k = 1, ..., K$ and $s = 1, 2, 3$, and select the median as the critical values, denoted $\tilde{x}^{(s)}_{M_k,(1-\alpha)}$, $\tilde{y}^{(s)}_{M_k,(1-\alpha)}$ and $\tilde{m}^{(s)}_{M_k,(1-\alpha)}$ in inference.

[15] Linton et al. (2005) provide the simulation evidence in favor of this approach.

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Table 1: Descriptive Statistics over 1988-2007

		OBS	MEAN	STDEV	SKEW	KURT	MIN	MED	MAX	JB	
1d	D^L	5046	0.03%	0.76%	-0.16	3.98	-4.78%	0.05%	4.75%	3354	***
	$D^\$$	5046	0.03%	0.78%	-0.14	3.38	-5.21%	0.05%	4.77%	2413	***
	E^L	5046	0.12%	0.92%	-0.53	4.19	-6.78%	0.15%	6.07%	3924	***
	$E^\$$	5046	0.05%	1.00%	-0.65	4.46	-7.42%	0.10%	6.19%	4538	***
3m	D^L	997	1.54%	6.67%	-0.89	1.93	-27.33%	2.75%	22.35%	288	***
	$D^\$$	997	1.60%	6.47%	-0.53	0.95	-23.31%	2.20%	22.35%	84	***
	E^L	997	7.35%	13.94%	-0.01	0.02	-35.97%	7.97%	51.39%	0	
	$E^\$$	997	2.70%	12.55%	-0.49	0.03	-42.36%	4.39%	33.59%	40	***
6m	D^L	985	3.03%	9.67%	-0.77	0.66	-35.02%	4.52%	29.57%	116	***
	$D^\$$	985	3.16%	8.95%	-0.65	0.46	-31.34%	4.08%	25.94%	78	***
	E^L	985	14.43%	22.81%	0.25	-0.18	-50.42%	13.18%	79.04%	12	***
	$E^\$$	985	5.14%	17.73%	-0.54	0.09	-59.00%	7.30%	42.56%	48	***
1y	D^L	959	5.81%	14.64%	-0.93	0.13	-40.67%	10.25%	33.47%	138	***
	$D^\$$	959	6.05%	13.65%	-0.93	0.35	-38.48%	9.94%	38.95%	145	***
	E^L	959	28.32%	37.58%	0.58	-0.20	-55.54%	20.12%	134.01%	56	***
	$E^\$$	959	10.01%	25.04%	-0.52	-0.07	-73.31%	12.86%	57.79%	44	***
5y	D^L	758	25.16%	33.99%	0.04	-1.02	-41.26%	22.67%	91.55%	33	***
	$D^\$$	758	26.42%	30.40%	-0.21	-1.03	-40.47%	25.49%	83.28%	39	***
	E^L	758	112.02%	117.35%	0.83	-0.71	-18.17%	59.42%	360.53%	103	***
	$E^\$$	758	31.05%	55.26%	-0.07	-1.31	-69.16%	30.16%	131.67%	55	***

Notes: D^L and $D^\$$ stand for the developed stock market returns over the given holding period measured in the local currency and the US dollar, respectively. Similarly for E^L and $E^\$$ for the emerging market. s and k are the standardized skewness and kurtosis, computed respectively by

$$s = \frac{\sum_{i=1}^{N}(r_i - \bar{r})^3/(N-1)}{\sigma^2} \quad \text{and} \quad k = \frac{\sum_{i=1}^{N}(r_i - \bar{r})^4/(N-1)}{\sigma^4}$$

JB stands for the Jarque-Berra statistic for the null hypothesis of normality of the respective holding period returns. When constructing the returns accumulated over 3-month, 6-month, 1-year and 5-year holding periods, we allow for overlapping with moving-step of 5days. *, ** and *** indicate a rejection of the null at 10, 5 and 1%, respectively.

Table 2: Descriptive Statistics over 1988-1996

		OBS	MEAN	STDEV	SKEW	KURT	MIN	MED	MAX	JB	
1d	D^L	2347	0.03%	0.59%	-0.09	5.34	-4.31%	0.04%	3.94%	2791	***
	$D^\$$	2347	0.03%	0.66%	-0.08	5.05	-5.21%	0.04%	4.77%	2495	***
	E^L	2347	0.21%	0.86%	-0.28	5.65	-6.78%	0.19%	6.07%	3151	***
	$E^\$$	2347	0.07%	0.90%	-0.51	5.98	-6.96%	0.08%	6.19%	3599	***
3m	D^L	457	1.64%	5.63%	-1.10	3.40	-24.92%	2.36%	18.93%	312	***
	$D^\$$	457	1.74%	5.37%	-0.63	1.18	-17.68%	2.03%	14.33%	57	***
	E^L	457	13.32%	14.09%	-0.11	-0.29	-23.59%	13.91%	51.39%	3	
	$E^\$$	457	4.04%	11.55%	-0.23	0.07	-27.66%	4.37%	33.59%	4	
6m	D^L	445	3.10%	8.06%	-0.70	0.26	-22.58%	4.03%	19.86%	38	***
	$D^\$$	445	3.34%	6.63%	-0.42	-0.07	-19.55%	3.56%	17.02%	13	***
	E^L	445	26.49%	23.30%	-0.09	-0.76	-29.37%	27.80%	79.04%	11	***
	$E^\$$	445	7.75%	15.30%	-0.32	-0.08	-35.69%	8.89%	42.56%	8	**
1y	D^L	419	6.00%	11.93%	-0.65	-0.07	-28.30%	7.81%	26.52%	30	***
	$D^\$$	419	6.56%	9.51%	-0.67	0.09	-21.73%	8.14%	23.99%	31	***
	E^L	419	54.04%	37.29%	0.00	-1.06	-14.78%	54.69%	134.01%	20	***
	$E^\$$	419	16.32%	19.75%	-0.15	-0.87	-27.38%	16.27%	56.15%	15	***
5y	D^L	218	20.76%	12.33%	0.12	-1.15	-0.98%	19.34%	43.82%	13	***
	$D^\$$	218	26.88%	11.80%	0.31	-1.36	8.45%	23.36%	47.82%	20	***
	E^L	218	277.35%	59.98%	-0.14	-1.51	160.99%	267.52%	360.53%	21	***
	$E^\$$	218	87.22%	21.67%	-0.19	-0.55	34.19%	91.59%	131.67%	4	

Notes: See the notes to Table 1.

Table 3: Descriptive Statistics over 1999-2007

		OBS	MEAN	STDEV	SKEW	KURT	MIN	MED	MAX	JB	
1d	D^L	2177	0.01%	0.87%	-0.01	2.69	-4.12%	0.05%	4.75%	659	***
	$D^\$$	2177	0.02%	0.86%	-0.03	2.37	-3.99%	0.04%	4.60%	510	***
	E^L	2177	0.06%	0.91%	-0.55	2.28	-5.64%	0.11%	3.70%	584	***
	$E^\$$	2177	0.06%	1.01%	-0.62	2.42	-5.83%	0.12%	4.06%	672	***
3m	D^L	436	1.01%	7.24%	-0.81	1.23	-27.33%	2.80%	22.35%	76	***
	$D^\$$	436	1.15%	7.13%	-0.53	0.60	-23.31%	2.17%	22.35%	27	***
	E^L	436	3.64%	10.59%	-0.27	-0.54	-21.89%	5.39%	30.32%	11	***
	$E^\$$	436	3.48%	11.76%	-0.37	-0.61	-25.80%	5.98%	31.56%	16	***
6m	D^L	436	1.80%	10.90%	-0.72	0.40	-35.02%	4.17%	29.57%	41	***
	$D^\$$	436	2.13%	10.80%	-0.55	-0.22	-31.34%	3.60%	25.94%	23	***
	E^L	436	6.99%	15.67%	-0.13	-0.92	-30.50%	8.54%	40.66%	16	***
	$E^\$$	436	6.65%	17.20%	-0.30	-1.01	-34.11%	9.26%	38.38%	25	***
1y	D^L	436	2.92%	16.85%	-0.77	-0.64	-40.67%	9.82%	33.47%	50	***
	$D^\$$	436	3.62%	17.04%	-0.62	-0.79	-38.48%	10.18%	38.95%	39	***
	E^L	436	11.67%	21.97%	-0.19	-0.55	-34.13%	13.94%	59.95%	8	**
	$E^\$$	436	10.57%	25.22%	-0.39	-0.68	-44.22%	15.02%	57.79%	19	***
5y	D^L	236	-8.59%	21.20%	0.81	-0.54	-41.26%	-17.12%	47.38%	28	***
	$D^\$$	236	-1.94%	24.37%	0.79	-0.66	-40.47%	-12.57%	57.67%	29	***
	E^L	236	42.37%	31.13%	0.03	-1.27	-14.16%	44.58%	96.18%	16	***
	$E^\$$	236	39.49%	43.51%	0.05	-1.10	-43.45%	29.91%	111.53%	12	***

Notes: See the notes to Table 1.

Table 4: Test Results for Stochastic and Spatial Dominance between Emerging and Developed Stock Market Returnsover 1988-2007

Holding Pperiod		3m				6m				1y				5y			
Order	Null	SD		SPD		SD		SPD		SD		SPD		SD		SPD	
		Panel A: Local Currency															
1st	$X \not\sim_1 Y$	2.090	***	1.373	***	3.079		0.530	***	0.452		0.970		0.000		0.000	
	$X \succ_1 Y$	2.090		1.373		3.079		0.530		0.452		0.970		0.000		0.000	
	$Y \succ_1 X$	12.415	***	7.833	***	28.311	***	2.847	***	12.594	***	8.826	***	24.180	***	7.523	***
2nd	$X \not\sim_2 Y$	0.269	***	0.147	***	0.513	**	0.071	***	0.060		0.161		0.000		0.000	
	$X \succ_2 Y$	0.269		0.147		0.513		0.071		0.060		0.161		0.000		0.000	
	$Y \succ_2 X$	1.834	***	0.933	***	8.062	***	0.618	***	6.969	***	3.488	***	53.429	***	12.574	***
3rd	$X \not\sim_3 Y$	0.039	***	0.017	***	0.113	**	0.011	**	0.016		0.030		0.000		0.000	
	$X \succ_3 Y$	0.039		0.017		0.113		0.011		0.016		0.030		0.000		0.000	
	$Y \succ_3 X$	0.624	**	0.359	**	4.237		0.341	***	6.296	***	3.543	***	119.008		33.365	***
		Panel B: US dollar															
1st	$X \not\sim_1 Y$	3.769	***	2.759	***	7.855	***	1.116	***	2.422	*	2.881	***	13.081	***	2.884	***
	$X \succ_1 Y$	3.769	*	2.759	*	7.855		1.116		2.422		2.881		13.081		2.884	
	$Y \succ_1 X$	7.379	***	4.705	***	18.318	***	1.734	***	9.429	***	5.929	***	16.364	***	3.369	
2nd	$X \not\sim_2 Y$	0.347	***	0.179	***	1.465	***	0.107	***	0.972	***	0.601	***	2.814	***	0.826	***
	$X \succ_2 Y$	0.655		0.363		1.937		0.198		0.972		0.721		5.646		1.098	
	$Y \succ_2 X$	0.347		0.179		1.465		0.107		1.224		0.601		2.814		0.826	
3rd	$X \not\sim_3 Y$	0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000	
	$X \succ_3 Y$	0.130		0.056		0.536		0.042		0.373		0.206		4.695		0.601	
	$Y \succ_3 X$	0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000	

Notes: SD and SPD stand for the stochastic and spatial dominance tests developed in Section 3, see (), () and (mc). We use the sub-sampling approach and obtain the critical values of both statistics for the sub-sample sizes ranging between $N^{0.7}$ and $N^{0.9}$ with a total of 31 grids. We then select the empirical median values as the critical values in inference. X and Y indicate the emerging and the developed stock market returns accumulated over the given holding period. $X \not\sim_s Y$ implies that there exists s-order (stochastic or spatial) dominance rank between X and Y for $s = 1, 2, 3$. $X \succ_s Y$ implies that X s-order (stochastically or spatially) dominates Y for $s = 1, 2, 3$. $Y \succ_s X$ implies that Y s-order (stochastically or spatially) dominates X for $s = 1, 2, 3$. *, ** and *** indicate a rejection of the null at 10, 5 and 1%, respectively.

Table 5: Test Results for Stochastic and Spatial Dominance between Emerging and Developed Stock Market Returns over 1988-1996

Holding Pperiod		3m				6m				1y				5y			
Order	Null	SD		SPD		SD		SPD		SD		SPD		SD		SPD	
		Panel A: Local Currency															
1st	$X \not\sim_1 Y$	0.561		0.368		0.284		0.297		0.000		0.000		3.007		0.000	
	$X \succ_1 Y$	0.561		0.368		0.284		0.297		0.000		0.000		5.168		0.000	
	$Y \succ_1 X$	12.443	***	8.289	***	13.463	***	9.264	***	14.785	***	10.079	***	5.177	***	11.698	***
2nd	$X \not\sim_2 Y$	0.042		0.026	**	0.022		0.030	*	0.000		0.000		1.072		0.000	
	$X \succ_2 Y$	0.042		0.026		0.022		0.030		0.000		0.000		6.554		0.000	
	$Y \succ_2 X$	2.467	***	1.262	***	4.947	***	2.517	***	9.804	***	4.941	***	5.756	***	19.355	***
3rd	$X \not\sim_3 Y$	0.004		0.002	**	0.003	**	0.003	**	0.000		0.000		0.557		0.000	
	$X \succ_3 Y$	0.004		0.002		0.003		0.003		0.000		0.000		8.791		0.000	
	$Y \succ_3 X$	0.909	***	0.517	***	2.712	***	1.558	***	8.836	***	5.075	***	6.623	***	49.751	***
		Panel B: US dollar															
1st	$X \not\sim_1 Y$	2.853	***	1.861	***	1.896	***	1.895	***	1.025		1.669	***	0.000		0.039	
	$X \succ_1 Y$	2.853	**	1.861		1.896		1.895		1.025		1.669		0.000		0.039	
	$Y \succ_1 X$	5.286	***	3.590	***	6.542		4.446	***	8.442	***	5.246	***	14.088	***	8.480	***
2nd	$X \not\sim_2 Y$	0.335	***	0.189	***	0.353	***	0.273	***	0.163	***	0.245	***	0.000		0.003	
	$X \succ_2 Y$	0.335		0.189	*	0.353		0.273		0.163	*	0.245		0.000		0.003	
	$Y \succ_2 X$	0.454	**	0.242	***	0.955	***	0.510	***	1.940	***	0.988	***	8.915	***	5.214	***
3rd	$X \not\sim_3 Y$	0.023	***	0.023	***	0.072	***	0.043	***	0.033	***	0.041	***	0.000		0.000	
	$X \succ_3 Y$	0.053		0.023		0.072		0.043		0.033		0.041		0.000		0.000	
	$Y \succ_3 X$	0.023		0.025		0.159		0.106		0.555		0.324	*	6.597	***	4.992	***

See also the notes to Table 4.

Table 6: Test Results for Stochastic and Spatial Dominance between Emerging and Developed Stock Market Returns over 1999-2007

Holding Pperiod		3m				6m				1y				5y			
Order	Null	SD		SPD		SD		SPD		SD		SPD		SD		SPD	
		Local Currency															
1st	$X \not\sim_1 Y$	1.437	**	0.862	***	0.718		1.054	***	0.000		0.000		4.671		0.000	
	$X \succ_1 Y$	1.437		0.862	*	0.718		1.054		0.000		0.000		4.671		0.000	
	$Y \succ_1 X$	6.178	***	3.493	***	6.745	***	3.873	***	6.178	***	4.162	***	5.186	***	4.617	***
2nd	$X \not\sim_2 Y$	0.121	***	0.099	***	0.033		0.103	***	0.000		0.000		1.147		0.000	
	$X \succ_2 Y$	0.121		0.099	**	0.033		0.103		0.000		0.000		1.651		0.000	
	$Y \succ_2 X$	0.548	***	0.255	***	1.077	***	0.523	***	1.826	***	1.043	***	1.304	***	3.417	***
3rd	$X \not\sim_3 Y$	0.013	***	0.013	***	0.000		0.011	***	0.000		0.000		0.209		0.000	
	$X \succ_3 Y$	0.013		0.013		0.000		0.011		0.000		0.000		0.885		0.000	
	$Y \succ_3 X$	0.091	***	0.042	*	0.258	***	0.134	***	0.754	*	0.489	***	0.702	***	3.513	***
		Panel B: US dollar															
1st	$X \not\sim_1 Y$	2.011	***	1.379	***	1.579		1.601	***	1.964		0.576		0.521		0.017	
	$X \succ_1 Y$	2.011	**	1.379	***	1.579		1.601	***	1.964		0.576		0.521		0.017	
	$Y \succ_1 X$	6.082	***	3.610	***	6.506	***	3.874	***	6.465	***	4.424	***	7.876	***	3.179	***
2nd	$X \not\sim_2 Y$	0.253	***	0.187	***	0.240	***	0.233	***	0.239	*	0.151	***	0.038		0.001	
	$X \succ_2 Y$	0.253		0.187	***	0.240		0.233	*	0.239		0.151		0.038		0.001	
	$Y \succ_2 X$	0.487	***	0.210	***	0.935	***	0.446	***	1.451	***	0.900	***	6.364	***	2.497	***
3rd	$X \not\sim_3 Y$	0.039	***	0.015	***	0.051	***	0.039	***	0.067	***	0.038	***	0.005		0.000	
	$X \succ_3 Y$	0.039		0.028		0.051		0.039		0.067		0.038		0.005		0.000	
	$Y \succ_3 X$	0.051		0.015		0.130	*	0.070		0.375		0.320	***	4.905	***	2.737	***

See also the notes to Table 4.

Table 7: Test Results for Stochastic and Spatial Dominance between Equity Returns measured in the Local Currency and in the US dollar over 1988-2007

Holding Pperiod		3m				6m				1y				5y			
Order	Null	SD		SPD		SD		SPD		SD		SPD		SD		SPD	
		Panel A: Emerging Markets															
1st	$X \not\sim_1 Y$	0.000		1.373	***	0.000		1.582	***	0.000		0.970		0.000		0.000	
	$X \succ_1 Y$	0.000		1.373		0.000		1.582		0.000		0.970		0.000		0.000	
	$Y \succ_1 X$	4.149	*	7.833	***	6.022	**	8.458	***	7.104	***	8.826	***	9.625	***	7.523	***
2nd	$X \not\sim_2 Y$	0.000		0.147	***	0.000		0.222	***	0.000		0.161		0.000		0.000	
	$X \succ_2 Y$	0.000		0.147		0.000		0.222		0.000		0.161		0.000		0.000	
	$Y \succ_2 X$	1.467	***	0.933	***	2.918	***	1.790	***	5.670	***	3.488	***	22.290	***	12.574	***
3rd	$X \not\sim_3 Y$	0.000		0.017	***	0.000		0.034	**	0.000		0.030		0.000		0.000	
	$X \succ_3 Y$	0.000		0.017		0.000		0.034		0.000		0.030		0.000		0.000	
	$Y \succ_3 X$	0.622	***	0.359	**	1.698	***	1.043	***	5.297	***	3.543	***	49.670	***	33.365	***
		Panel B: Developed Markets															
1st	$X \not\sim_1 Y$	1.140	**	2.759	***	1.370	***	3.206	***	1.647	***	2.881	***	2.070	***	2.884	***
	$X \succ_1 Y$	1.140	*	2.759	*	1.370		3.206	*	1.647		2.881		2.288		2.884	
	$Y \succ_1 X$	1.362		4.705	***	1.625	*	5.043	***	2.196	**	5.929	***	2.070		3.369	
2nd	$X \not\sim_2 Y$	0.018		0.179	***	0.000		0.298	***	0.000		0.601	***	0.000		0.826	***
	$X \succ_2 Y$	0.037		0.363		0.128		0.582		0.226		0.721		0.782	*	1.098	
	$Y \succ_2 X$	0.018		0.179		0.000		0.298		0.000		0.601		0.000		0.826	
3rd	$X \not\sim_3 Y$	0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000	
	$X \succ_3 Y$	0.008		0.056		0.031		0.126		0.068		0.206		0.546	**	0.601	
	$Y \succ_3 X$	0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000	

Notes: X and Y indicate the stock market returns measured respectively in the Local Currency and in the US dollar, and accumulated over the given holding period. See also the notes to Table 4.

Table 8: Test Results for Stochastic and Spatial Dominance between Equity Returns measured in the Local Currency and in the US dollar over 1988-1996

Holding Pperiod		3m				6m				1y				5y			
Order	Null	SD		SPD		SD		SPD		SD		SPD		SD		SPD	
		Panel A: Emerging Markets															
1st	$X \not\approx_1 Y$	0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000	
	$X \succ_1 Y$	0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000	
	$Y \succ_1 X$	6.923	***	4.453	***	9.102	***	5.136	***	10.832	***	6.144	***	14.765	***	8.529	***
2nd	$X \not\approx_2 Y$	0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000	
	$X \succ_2 Y$	0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000	
	$Y \succ_2 X$	1.987	***	1.005	***	3.962	***	1.993	***	7.748	***	3.892	***	28.050	***	13.824	***
3rd	$X \not\approx_3 Y$	0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000	
	$X \succ_3 Y$	0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000	
	$Y \succ_3 X$	0.782	***	0.437	***	2.157	***	1.259	***	6.578	***	3.899	***	48.118	***	31.731	***
		Panel B: Developed Markets															
1st	$X \not\approx_1 Y$	0.889	***	0.262		1.517	***	0.249		2.098		1.081	***	0.000		0.000	
	$X \succ_1 Y$	0.889		0.471		1.517		0.253		2.098		1.081		3.454		0.898	*
	$Y \succ_1 X$	0.982		0.262		2.275	***	0.249		2.489		1.114	***	0.000		0.000	
2nd	$X \not\approx_2 Y$	0.002		0.004		0.000		0.000		0.000		0.000		0.000		0.000	
	$X \succ_2 Y$	0.031		0.016		0.149		0.029		0.315		0.148	***	0.906	***	0.317	***
	$Y \succ_2 X$	0.002		0.004		0.000		0.000		0.000		0.000		0.000		0.000	
3rd	$X \not\approx_3 Y$	0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000	
	$X \succ_3 Y$	0.006		0.002		0.026		0.008		0.076		0.036	***	0.230	***	0.134	***
	$Y \succ_3 X$	0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000	

Notes: X and Y indicate the stock market returns measured respectively in the Local Currency and in the US dollar, and accumulated over the given holding period. See also the notes to Table 4.

Table 9: Test Results for Stochastic and Spatial Dominance between Stock Market Returns measured in the Local Currency and in the US dollar over 1999-2007

Holding Pperiod		3m				6m				1y				5y			
Order	Null	SD		SPD		SD		SPD		SD		SPD		SD		SPD	
		Panel A: Emerging Markets															
1st	$X \not\sim_1 Y$	1.006	***	0.501	***	1.292	***	0.594	***	1.437	***	0.629	***	1.953	***	0.386	***
	$X \succ_1 Y$	1.341	*	0.677	***	1.435	*	0.594	**	1.437		0.635		3.255	*	0.386	
	$Y \succ_1 X$	1.006	**	0.501	*	1.292		0.657	***	1.964	**	0.629		1.953		1.353	***
2nd	$X \not\sim_2 Y$	0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000	
	$X \succ_2 Y$	0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000	
	$Y \succ_2 X$	0.130		0.079		0.184		0.115		0.429		0.178		1.132	*	0.787	***
3rd	$X \not\sim_3 Y$	0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000	
	$X \succ_3 Y$	0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000	
	$Y \succ_3 X$	0.036		0.021		0.076		0.041		0.273		0.102		1.023	**	0.983	***
		Panel B: Developed Markets															
1st	$X \not\sim_1 Y$	0.718	***	0.293	***	0.574		0.207		0.431		0.144		0.065		0.000	
	$X \succ_1 Y$	1.006		0.348		1.005		0.406		0.910		0.567		3.059	*	0.585	
	$Y \succ_1 X$	0.718		0.293		0.574		0.207		0.431		0.144		0.065		0.000	
2nd	$X \not\sim_2 Y$	0.003		0.000		0.000		0.000		0.000		0.000		0.000		0.000	
	$X \succ_2 Y$	0.027		0.026		0.077		0.040		0.145		0.064		1.022	***	0.302	
	$Y \succ_2 X$	0.003		0.000		0.000		0.000		0.000		0.000		0.000		0.000	
3rd	$X \not\sim_3 Y$	0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000	
	$X \succ_3 Y$	0.008		0.006		0.022		0.013		0.045		0.024		0.532	***	0.186	
	$Y \succ_3 X$	0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000	

Notes: X and Y indicate the stock market returns measured respectively in the Local Currency and in the US dollar, and accumulated over the given holding period. See also the notes to Table 4.

Table 10: Test Results for Stochastic and Spatial Dominance between Subperiods in Emerging Markets

Holding Pperiod		3m				6m				1y				5y			
Order	Null	SD		SPD		SD		SPD		SD		SPD		SD		SPD	
		Panel A: Local Currency															
1st	$X \approx_1 Y$	0.098		0.027		0.000		0.000		0.000		0.000		0.000		0.000	
	$X \succ_1 Y$	0.098		0.027		0.000		0.000		0.000		0.000		0.000		0.000	
	$Y \succ_1 X$	5.356	***	3.043	***	6.356	***	3.560	***	7.725	***	4.764	***	10.645	***	7.135	***
2nd	$X \approx_2 Y$	0.002		0.002		0.000		0.000		0.000		0.000		0.000		0.000	
	$X \succ_2 Y$	0.002		0.002		0.000		0.000		0.000		0.000		0.000		0.000	
	$Y \succ_2 X$	1.427	***	0.728	***	2.921	***	1.517	***	6.176	***	3.229	***	25.000	***	13.418	***
3rd	$X \approx_3 Y$	0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000	
	$X \succ_3 Y$	0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000	
	$Y \succ_3 X$	0.468	***	0.311	***	1.549	***	0.968	***	5.959	***	3.397	***	53.684	***	34.259	***
		Panel B: US Dollar															
1st	$X \approx_1 Y$	1.184	***	0.588	***	1.312	***	0.388	**	0.382		0.054		0.000		0.000	
	$X \succ_1 Y$	1.403		0.669		1.312		0.388		0.382		0.054		0.000		0.000	
	$Y \succ_1 X$	1.184		0.588		1.535		1.086		2.144		1.625		6.184	***	4.738	***
2nd	$X \approx_2 Y$	0.010	*	0.002		0.009		0.000		0.000		0.000		0.000		0.000	
	$X \succ_2 Y$	0.010		0.002		0.009		0.000		0.000		0.000		0.000		0.000	
	$Y \succ_2 X$	0.093		0.056		0.293		0.156		0.841		0.555		5.083	***	4.032	***
3rd	$X \approx_3 Y$	0.008	***	0.000		0.001	**	0.000		0.000		0.000		0.000		0.000	
	$X \succ_3 Y$	0.010		0.000		0.001		0.000		0.000		0.000		0.000		0.000	
	$Y \succ_3 X$	0.008		0.014		0.090		0.073		0.620		0.389		4.811	***	4.423	***

Notes: X and Y indicate the stock market returns accumulated over the given holding period during 1988-1996 and during 1999-2007, respectively. See also the notes to Table 4.

Table 11: Test Results for Stochastic and Spatial Dominance between Subperiods in Developed Markets

Holding Pperiod		3m				6m				1y				5y			
Order	Null	SD		SPD		SD		SPD		SD		SPD		SD		SPD	
		Panel A: Local Currency															
1st	$X \not\approx_1 Y$	1.076	***	0.586	***	0.720		0.488	*	1.617	***	0.314		0.135		0.032	
	$X \succ_1 Y$	1.076		0.586		0.720		0.488		1.617		0.314		0.135		0.032	
	$Y \succ_1 X$	1.655		1.130	*	1.723		1.401	*	2.849		1.736	***	7.398	***	3.954	***
2nd	$X \not\approx_2 Y$	0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000	
	$X \succ_2 Y$	0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000	
	$Y \succ_2 X$	0.155		0.087		0.255		0.163		0.538		0.276	***	3.125	***	1.654	***
3rd	$X \not\approx_3 Y$	0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000	
	$X \succ_3 Y$	0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000	
	$Y \succ_3 X$	0.020		0.017		0.084		0.052		0.270		0.133	***	1.605	***	1.006	***
		Panel B: US Dollar															
1st	$X \not\approx_1 Y$	1.572	***	0.712	***	1.669	***	0.769	***	1.690	***	0.656		0.226		0.012	
	$X \succ_1 Y$	1.572		0.712		1.669	**	0.769		1.690		0.656		0.226		0.012	
	$Y \succ_1 X$	1.694		1.058		2.359		1.493		3.318		2.100	***	7.398	***	4.271	***
2nd	$X \not\approx_2 Y$	0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000	
	$X \succ_2 Y$	0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000	
	$Y \succ_2 X$	0.158		0.085		0.336		0.173		0.676		0.354	***	3.082	***	1.702	***
3rd	$X \not\approx_3 Y$	0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000	
	$X \succ_3 Y$	0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000	
	$Y \succ_3 X$	0.020		0.017		0.085		0.046		0.338		0.147	***	1.810	***	1.149	***

Notes: X and Y indicate the stock market returns accumulated over the given holding period during 1988-1996 and during 1999-2007, respectively. See also the notes to Table 4.

Figure 1: Time Series Plot of Emerging and Developed Equity Daily Returns over 1988-2007

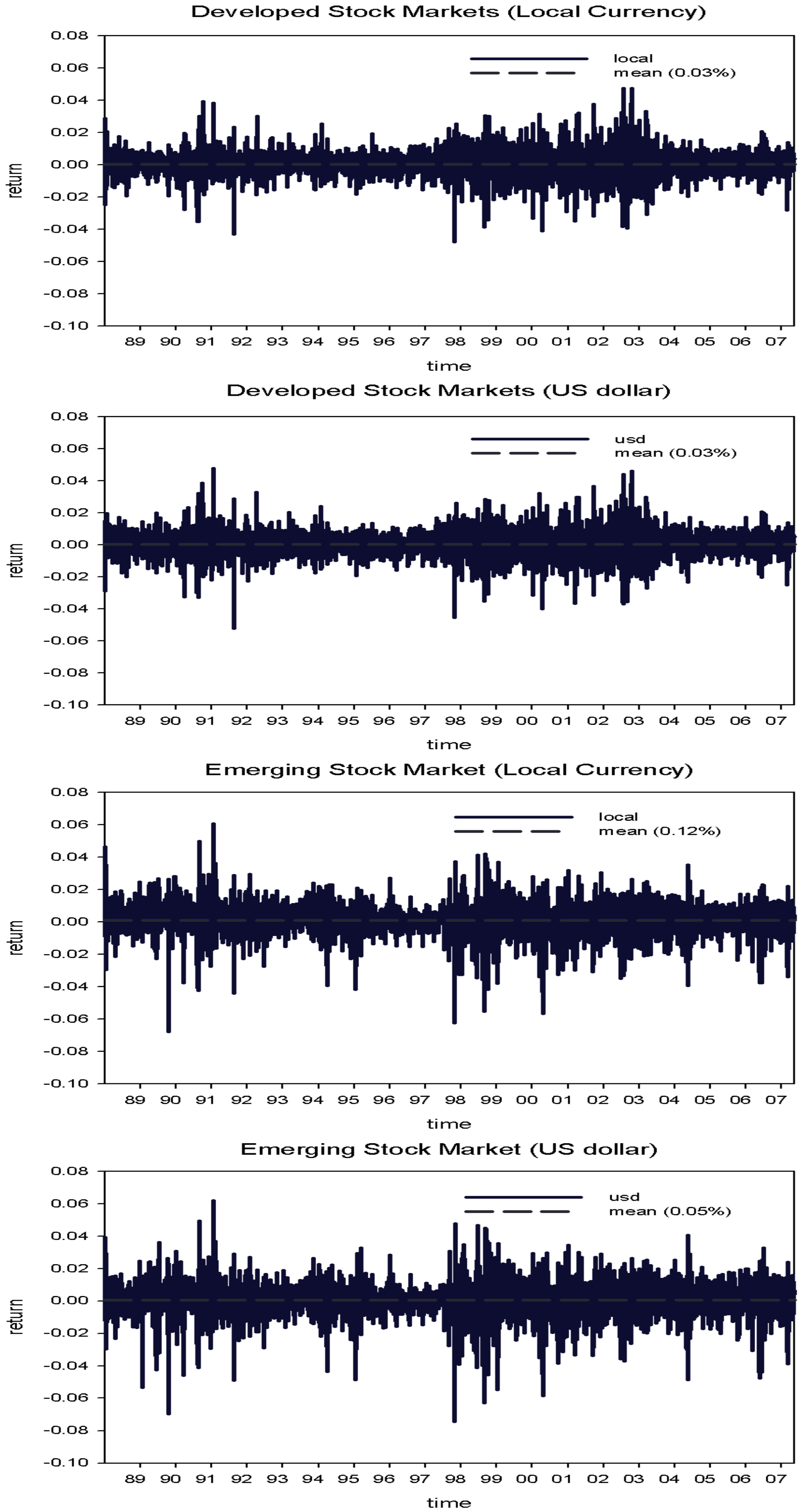
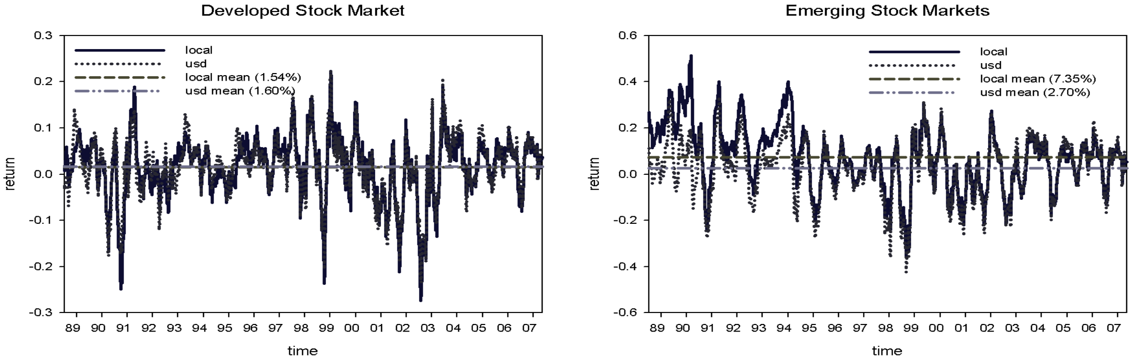
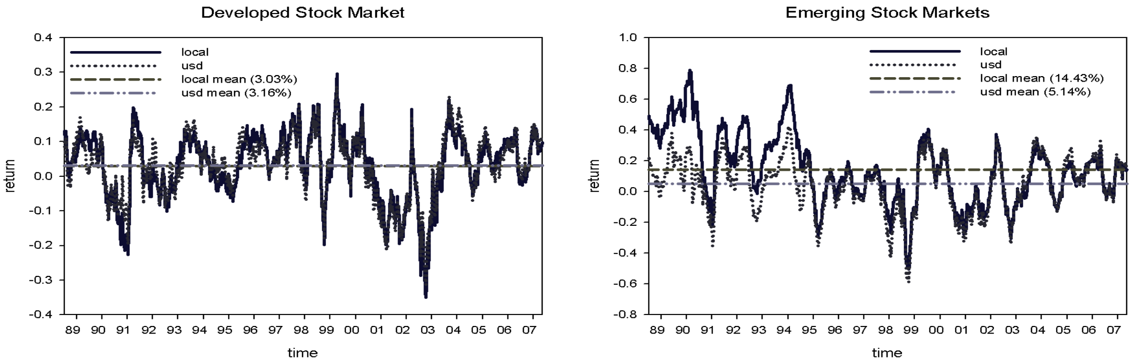


Figure 2: Time Series Plot of Emerging and Developed Equity Returns Accumulated over Different Holding Periods over 1988-2007

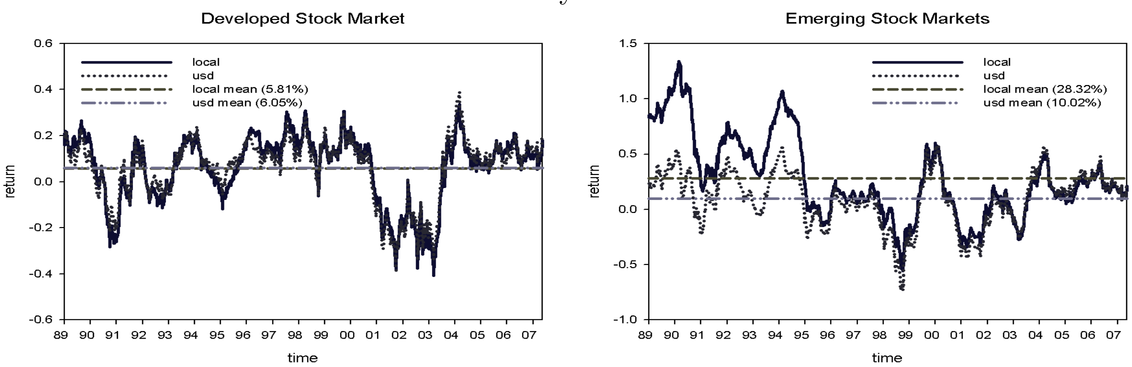
3-month



6-month



1-year



5-year

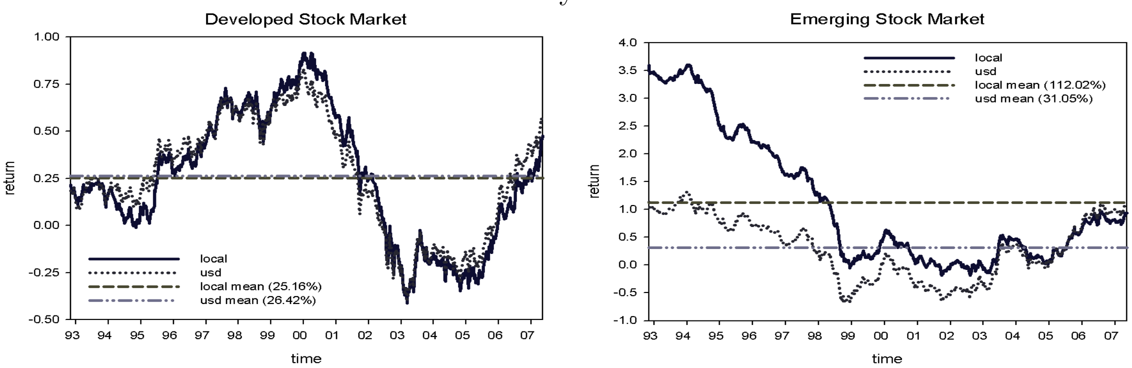
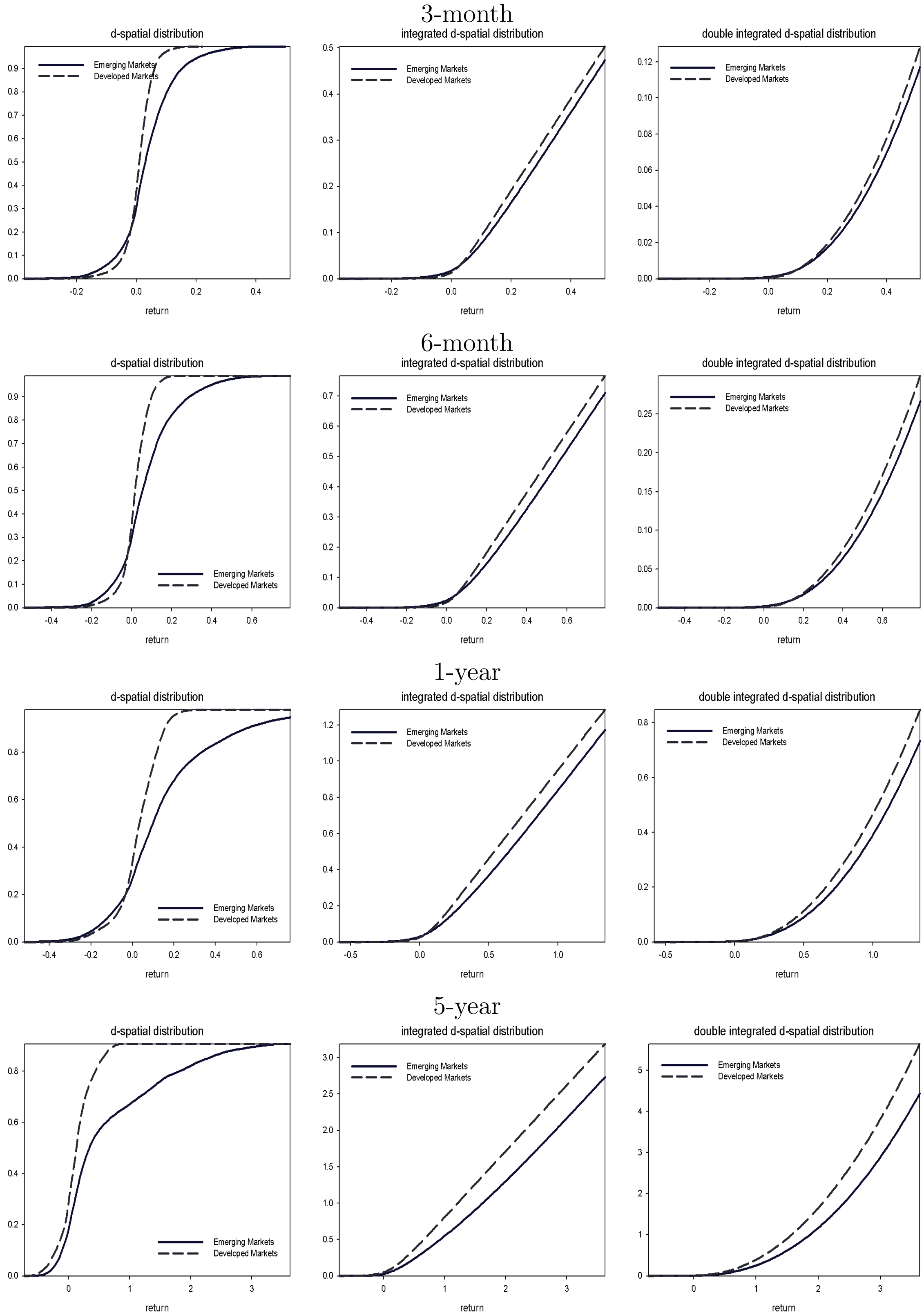
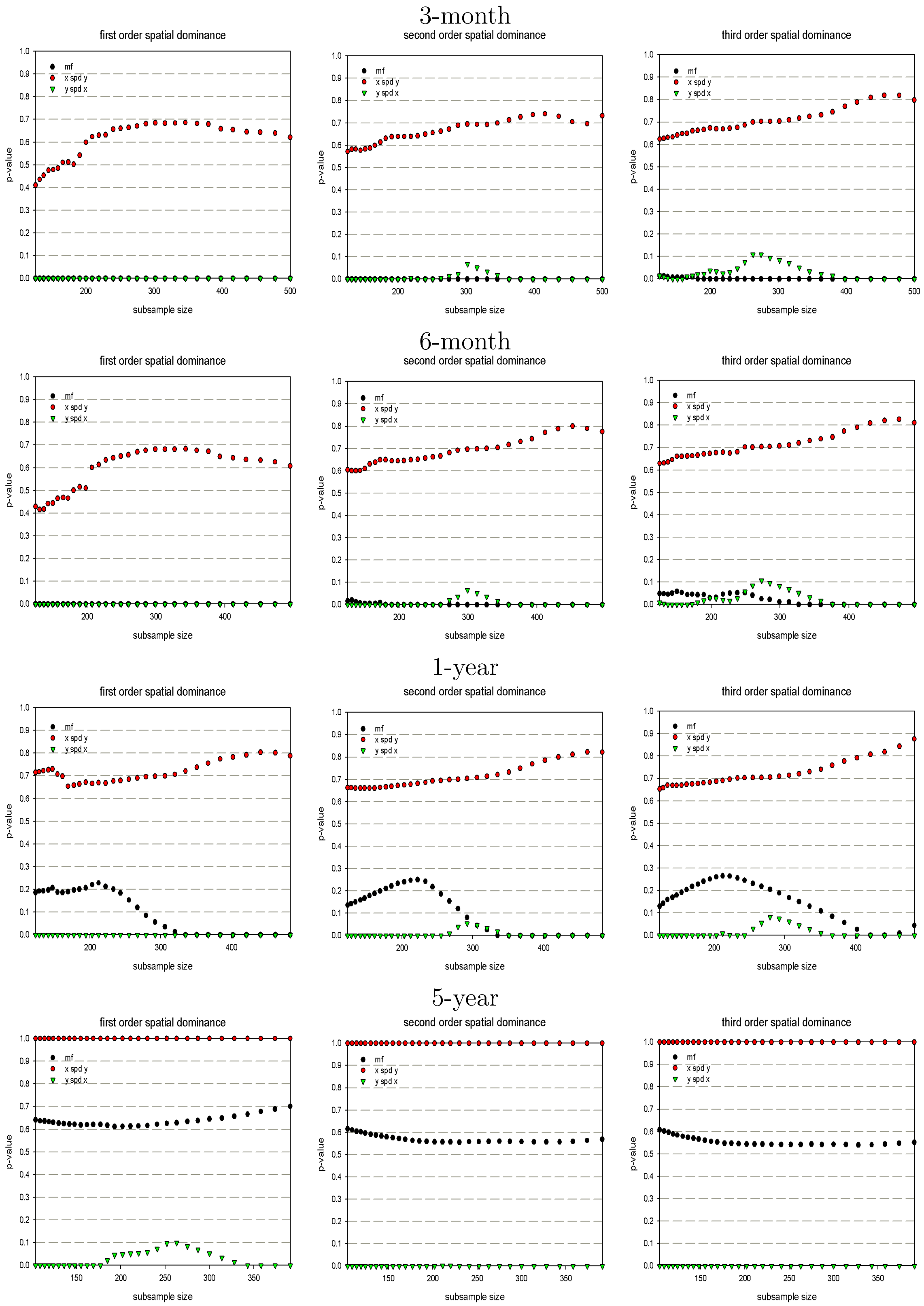


Figure 3: d-Spatial Distribution Functions of Equity Returns Accumulated over Different Holding Periods and Measured in the Local Currency over 1988-2007



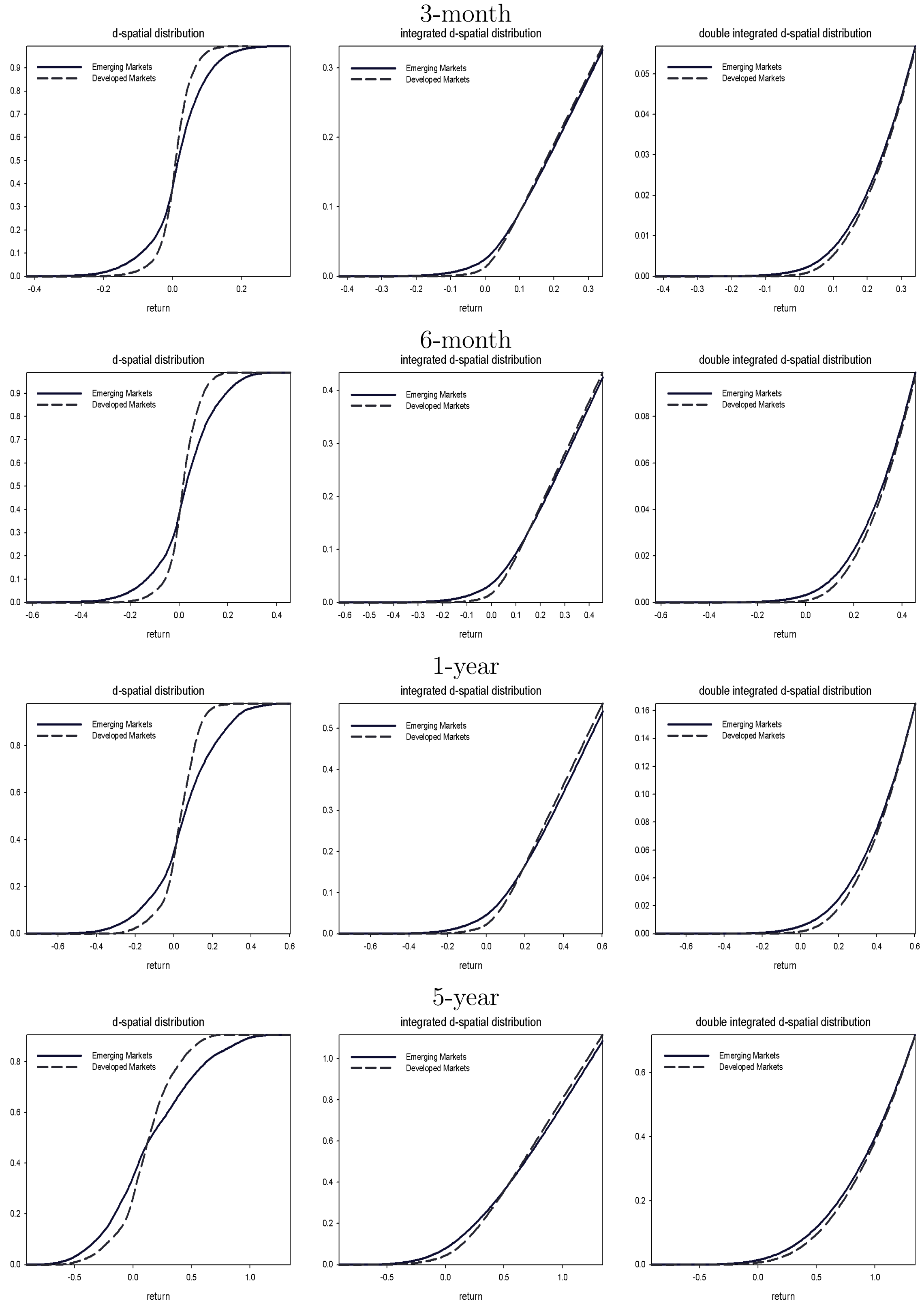
Notes: See the notes to Table 4.

Figure 4: The p-values of Spatial Dominance Tests for Equity Returns measured in Local Currency across Different Sub-sample Sizes over 1988-2007



Notes: See the notes to Table 4.

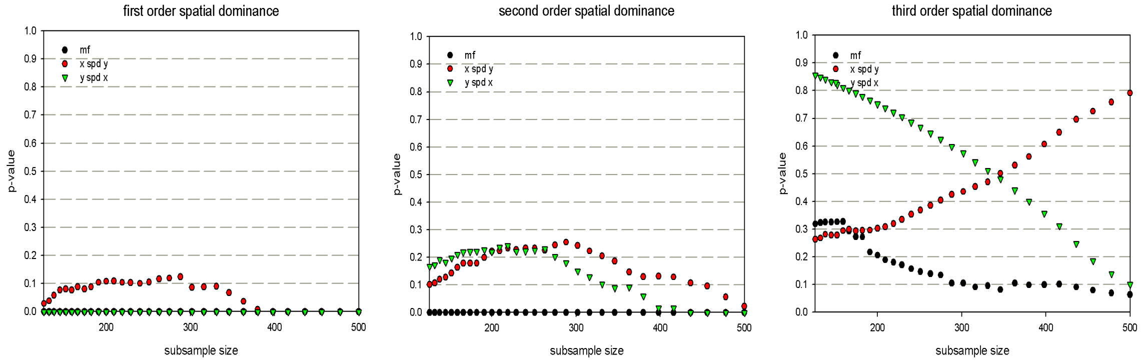
Figure 5: d-Spatial Distribution Functions of Equity Returns Accumulated over Different Holding Periods and Measured in the US dollar over 1988-2007



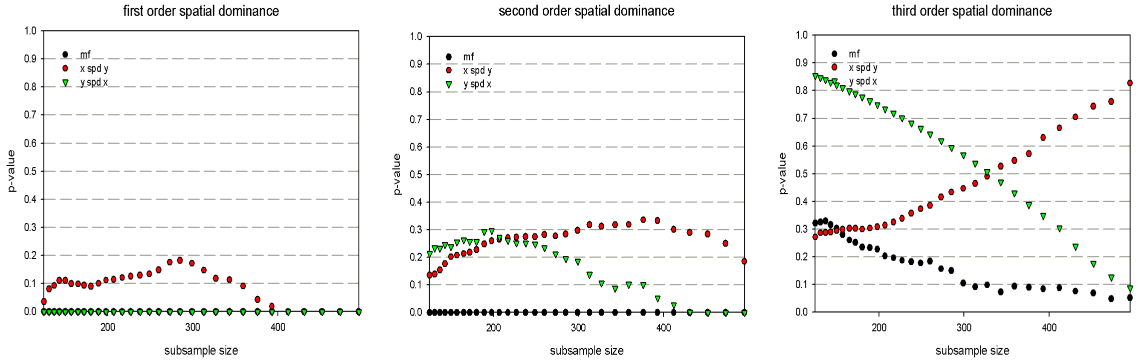
Notes: See the notes to Table 4.

Figure 6: The p-value of Spatial Dominance Tests for Equity Returns measured in the US Dollar across Different Sub-sample Sizes over 1988-2007

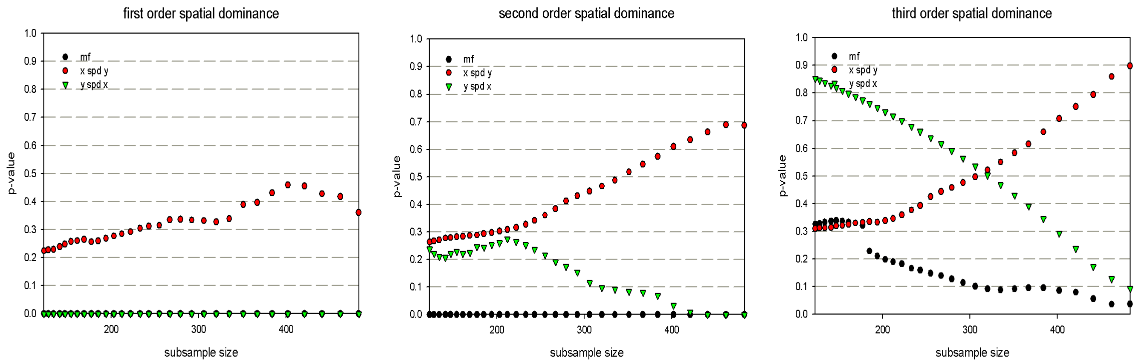
3-month



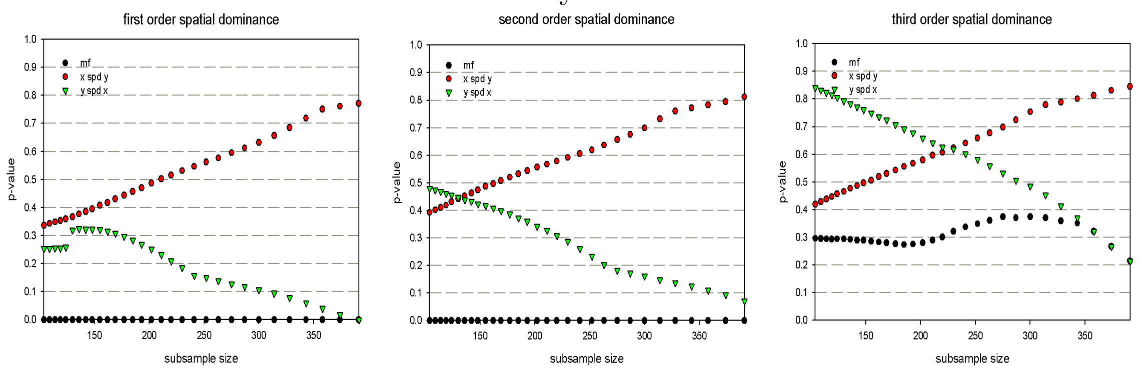
6-month



1-year



5-year



Notes: See the notes to Table 4.