The Volatility Effect in Emerging Markets

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Abstract

We examine the empirical relation between risk and return in emerging equity markets and find that this relation is flat, or even negative. This is inconsistent with theoretical models such as the CAPM, which predict a positive relation, but consistent with the results of studies for developed equity markets. The volatility effect appears to be growing stronger over time, which we argue might be related to the increased delegated portfolio management in emerging markets. Finally, we find that the volatility effect in emerging markets is only weakly related to that in developed equity markets, which argues against a common-factor explanation.

JEL Classification: F20, G11, G12, G14, G15

Keywords: volatility effect, asset pricing, emerging markets, CAPM, alpha, low-volatility

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1. Introduction

In this paper we examine the empirical relation between risk and return in emerging equity markets. The Nobel-prize winning Sharpe-Lintner Capital Asset Pricing Model (CAPM) postulates that the expected return on a stock is linearly proportional to its market beta. However, the initial empirical tests of the CAPM for the U.S. equity market already indicated that low-beta stocks have higher returns than predicted by the CAPM; see, e.g., Black, Jensen and Scholes (1972), Fama and MacBeth (1973) and Haugen and Heins (1975). Whereas some anomalies tend to weaken or even disappear following their public dissemination, the beta effect only seems to have been growing stronger over time. For instance, the seminal Fama and French (1992) paper documents that the relation between beta and U.S. stock returns is essentially flat over the 1963-1990 period, especially after correcting for size effects. More evidence for a flat, or even negative, relation between risk and return is given by Black (1993), Haugen and Baker (1991, 1996) and Falkenstein (1994), who look at similar or longer sample periods.

More recently, Blitz and van Vliet (2007) provide international evidence, showing that the relation between risk and return is not only negative in the U.S., but also in the European and Japanese equity markets over the 1986 to 2006 period. In addition, they find that the effect is even stronger when risk is measured using simply volatility instead of beta. For the U.S. stock market, Baker, Bradley and Wurgler (2011) confirm that the volatility effect presents an even bigger anomaly than the related beta effect over the 1968 to 2008 period. In addition, Clarke, de Silva and Thorley (2010) report that the relation between volatility and expected stock returns is flat over the extended 1931 to 2008 period. Ang, Hodrick, Xing and Zhang (2006, 2009) show that also very short-term (past one month daily) idiosyncratic volatility is negatively related to subsequent stock returns in the U.S. and other G7 stock markets, providing further evidence of the robustness of the anomalous empirical relation between risk and return.

In this paper we extend the existing literature by analyzing the empirical relation between risk and return in emerging equity markets. Emerging markets have become increasingly important to investors due to their fast growing economies. This is clearly reflected in the composition of the MSCI All Countries index, in which the weight of emerging markets has grown from roughly 1 percent in 1988 to around 15 percent nowadays. This increase has mostly come from issuance of new shares, and to a smaller extent from higher realized returns. However, emerging markets have also been characterized by a high volatility and multiple crises, such as Mexico 1994, Asia 1997 and Russia 1998. Several studies have examined the cross-section of stock returns in emerging markets, and conclude that the classic size, value and momentum effects are also present in these markets; see, e.g., Fama and French (1998), Patel (1998), Rouwenhorst (1999) and van der Hart, Slagter and van Dijk (2003). The empirical relation between risk, in terms of either volatility or beta, and return in emerging markets has not received much attention though. One of the few exceptions is Rouwenhorst (1999), who observes that beta is not related to return in emerging markets over the 1982 to 1997 period.

Our analysis of the empirical relation between risk and return in emerging markets is relevant for at least three reasons. First, by considering a fresh dataset with data through 2010 we can test whether conclusions on the empirical relation between risk and return in developed equity markets carry over to emerging equity markets. If the results of our out-of-sample test on emerging markets are similar to previous findings for the U.S. and other developed equity markets, this reduces the probability of a spurious result that might be attributable to data mining. Moreover, by relating the volatility effect in emerging markets to the volatility effect in developed markets, we can assess if the effects in different markets are driven by a common component. High correlations between the alphas in different markets suggest that the volatility effect may represent a global risk factor, while low correlations are indicative of mispricing occurring independently in different markets.

Second, our new sample enables us to address the main criticisms existing studies have received. For example, Bali and Cakici (2008) argue that the negative empirical relation between risk and return is driven by small-caps, especially the strong negative returns of high (idiosyncratic) volatility stocks. We address this concern by including only constituents of the S&P/IFC Investable Emerging Markets Index in our sample, and additionally by conducting a robustness test on the 50% largest stocks within this already liquid universe. Others, such as Scherer (2010), have argued that some of the effect may be due to exposure to the classic value premium. We therefore also adjust for such implicit factor loadings, using both parametric and non-parametric techniques. Yet another critique, by Amenc, Martellini, Goltz and Sahoo (2011), is that the relation between risk and return turns positive over longer holding periods. We therefore also analyze the performance characteristics of portfolios sorted on past risk over holding periods up to 5 years.

Third, emerging markets can shed new light on the different hypotheses which have been proposed in the literature to rationalize the apparently anomalous empirical relation between risk and return. Some, such as Black (1993), Frazzini and Pedersen (2010), Hong and Sraer (2012), and de Giorgi and Post (2011) attribute the effect to leverage and short-selling constraints, while other explanations relate to agency issues involved with delegated portfolio management; see, for example, Brennan (1993), Karcesiki (2002), Falkenstein (2009), Blitz (2012) and Baker and Haugen (2012). Emerging markets are an interesting test case, as due to their rapid growth and progressive liberalization over the past decades, they have grown from a niche into a mainstream asset class, resulting in increased participation of delegated portfolio managers. For developed markets, Blitz and van Vliet (2007) have suggested that the volatility effect has strengthened over time, something which we can now test out-of-sample for dozens of new emerging countries.

Our main finding is that, similar to the results documented previously for the U.S. and other developed equity markets, the empirical relation between risk and return is negative in emerging equity markets, and more strongly so when volatility instead of beta is used to measure risk. Specifically, a monthly rebalanced top-minus-bottom quintile portfolio based on past 3-year volatility exhibits a negative raw return spread of -4.4 percent per annum over our 1989-2010 sample period. Adjusted for differences in market beta this amounts to a statistically significant negative alpha spread of -8.8 percent. In line with other studies on the volatility effect, we observe that the negative alpha of the most volatile stocks is larger than the positive alpha of the least volatile stocks, and that the volatility effect is stronger than the closely related beta effect.

We also find that our results are robust to various critiques of the volatility effect that have been put forward in the literature. Specifically, we find that the alpha spread remains large and significant (i) after additionally controlling for size, value and momentum effects, (ii) if the 50% smallest least liquid stocks in the sample are excluded from the analysis, and (iii) if the holding period is extended from 1 month up to 5 years. We also find that the volatility effect has strengthened over time, again in line with results for developed markets. Specifically, the alpha spread amounts to -3.1 percent in the first half of our sample period (1989-1999), versus -14.4 percent during the second half of our sample period (2000-2010). Finally, we find low correlations between the volatility effects in emerging and developed equity markets, which argues against a common-factor explanation, i.e. the possibility that the volatility effect might reflect a global systematic risk factor. We conclude that there exists a significant, robust and distinct volatility effect within emerging markets, which appears to be growing stronger over time. Our findings indicate that the relation between risk and return in emerging markets is very similar to developed markets and are consistent with the hypothesis that agency issues involved with delegated portfolio management contribute to the volatility effect.

The remainder of this paper is organized as follows. In Section 2 we first describe our data and methodology, in Section 3 we present our empirical results and in Section 4 we conclude.

2. Data and Methodology

In this section we describe the data and methodology used throughout this paper.

2.1 Data

We construct our sample by taking, at the end of every month, all stocks included in the S&P/IFC Investable Emerging Markets Index at that specific point in time. Our sample covers the period from the inception of this index, at the end of December 1988, until December 2010. The S&P/IFC Investable Emerging Markets Index is a subset of the much broader S&P/IFC Global Emerging Markets Index, containing only stocks considered to be accessible and sufficiently liquid for international investors. One small country, Zimbabwe, is removed from our sample because of unreliable price data. Our final sample covers stocks from 30 different emerging markets. Figure 1 shows that the total number of stocks in our sample starts off low, but grows progressively over time. During the first two years our sample contains less than 200 stocks, but by the end of 2010 the number of stocks has risen to over 1,800. The average number of stocks is around 1,000. We note that jumps in the number of index constituents are typically the result of countries entering or leaving the universe. For example, China is included in the index from October 1995 onwards, while Portugal was removed from the index in March 1999.

<<< INSERT FIGURE 1 ABOUT HERE >>>

We gather monthly total stocks returns in local currency as well as in U.S. dollars, taking into account dividends, stock splits and other capital adjustments. Our first data source for returns is Interactive Data Exshare. If not available, return data from MSCI are used instead. If also not available, we calculate total returns using data from S&P/IFC. Monthly returns above 500% are truncated at this level. In addition to returns, we gather free-float adjusted market capitalization data from S&P/IFC and accounting data (book-to-price ratios) from, in order of preference, MSCI, Thomson Financial Worldscope and S&P/IFC. Finally, we obtain the one-month U.S. Treasury bill rate, and the global market, size, value, and momentum factors from the data library of Kenneth French.

2.2 Methodology

Our methodology consists of creating, at the end of every month, equally-weighted quintile portfolios based on ranking stocks on their past volatility. The top quintile contains the stocks with the highest volatility and the bottom quintile the stocks with the lowest volatility. Similar to, for example, Rouwenhorst (1999) and van der Hart, Slagter and van Dijk (2003) we construct the portfolios in a country neutral manner, meaning that the stocks for a given country are distributed uniformly across the various quintile portfolios. We next calculate for each portfolio the total return in U.S. dollars in excess of the one-month Treasury bill rate over the subsequent month.

Similar to Blitz and van Vliet (2007), we calculate the past volatility of a stock by taking the standard deviation of its monthly total returns in local currency over the preceding three years. The only difference is that we consider return data with a monthly instead of a weekly frequency, due to data limitations for emerging markets. In a robustness test we look at the effects of calculating volatility over shorter or longer look-back periods, and the effects of using daily instead of monthly data (which is available for part of our sample period). In addition, we consider the robustness of our findings to using alternative risk measures, such as beta or mean absolute deviation (MAD), instead of volatility. The past beta of a stock is calculated by regressing its monthly total returns in local currency over the past three years on the total returns in local currency of the S&P/IFC Investable index for the country to which the stock belongs. The past MAD of a stock is calculated on its monthly total returns in local currency over the preceding three years. The use of this measure instead of volatility is suggested by, for example, Goldstein and Taleb (2007). We require that at least half of the 36 monthly return observations are available when calculating a volatility, beta or MAD.

For each quintile portfolio we report the annualized average return, volatility and Sharpe ratio. For the annualized return we report both the arithmetic and the geometric average, but focus on the latter in order to account for compounding effects, which are particularly relevant when comparing portfolios with different volatilities; see, e.g. van Vliet, Blitz and van der Grient (2011). In addition, we report alpha levels and t-statistics for each portfolio based on local versions of the 1-, 3- and 4-factor models. All t-statistics are Newey-West adjusted. The alphas are obtained by first regressing the monthly portfolio returns on a number of factors and next using the estimated betas to adjust the geometric average portfolio returns for these implicit factor exposures. The 1-factor alpha is obtained by regressing the portfolio excess returns on the excess returns of the emerging markets market portfolio, as in:

$$(1) \quad R_{p,t} - R_{f,t} = \alpha_p + \beta_{p,M*} (R_{M*,t} - R_{f,t}) + \varepsilon_{p,t}$$

where $R_{p,t}$ is the return on portfolio p in period t, $R_{f,t}$ is the risk-free return in period t, α_p is the alpha of portfolio p, $R_{M*,t}$ is the return on the emerging markets market portfolio in period t, $\beta_{p,M*}$ is the beta of portfolio p with respect to the emerging markets market portfolio and $\varepsilon_{p,t}$ is the idiosyncratic return of portfolio p in period t. We define the emerging markets market portfolio as the equally-weighted universe of all emerging markets stocks in our sample.

In order to calculate the 3-factor alpha, we add SMB (size) and HML (value) proxies to the regression, and in order to calculate the 4-factor alpha we additionally add a UMD (momentum) proxy, as in:

$$(2) \quad R_{p,t} - R_{f,t} = \alpha_p + \beta_{p,\,M^*} (R_{M^*,t} - R_{f,t}) + \beta_{p,SMB^*} R_{SMB^*,t} + \beta_{p,HML^*} R_{HML^*,t} + \varepsilon_{p,t}$$

$$(3) \quad R_{p,t} - R_f = \alpha_p + \beta_{p,\,M^*} (R_{M^*,t} - R_{f,t}) + \beta_{p,SMB^*} R_{SMB^*,t} + \beta_{p,HML^*} R_{HML^*,t} + \beta_{p,UMD^*} R_{UMD^*,t} + \varepsilon_{p,t}$$

where $R_{SMB^*,t}$, $R_{HML^*,t}$ and $R_{UMD^*,t}$ denote the return on the size, value and momentum factors in emerging markets and β_{p,SMB^*}, β_{p,HML^*} and β_{p,UMD^*} denote the beta of portfolio p with respect to the size, value and momentum factors in emerging markets. The size, value and momentum factors for emerging markets are calculated by ranking stocks, again in a country neutral manner, on their log market capitalization, book-to-market ratio and past 12-minus-1 month total return respectively, and taking the difference in return between the equally-weighted top and bottom quintiles.

The use of local 1-, 3- and 4-factor models, similar to for example Rouwenhorst (1998) and Ang, Hodrick, Xing and Zhang (2009), allows us to determine whether a possible volatility effect in emerging markets is distinct from the size, value and momentum effects that have previously been documented for these markets. In a robustness test we additionally examine if the volatility effect in emerging markets remains significant from a global asset pricing perspective. For this analysis we apply the International CAPM of Fama and French (1998) and its 3-factor and 4-factor extensions.[1] Specifically, we re-run regressions (1), (2) and (3) using the global market, size, value, and momentum factors, taken from the data library of Kenneth French[2], instead of our local emerging markets proxies for these factors.

[1] An alternative version of the International CAPM which has been used in the literature is a model which augments the standard CAPM with foreign currency risk premium factors. However, this model is not empirically applicable to emerging markets because with 30 emerging countries the total number of factors would approach the number of observations (36). The model further assumes that all markets are fully integrated and all currency risk can be hedged, which is not possible in practice for many currencies in emerging markets.

[2] The global market, size, value and momentum factors in the data library of Kenneth French are not available for the initial months of our sample period (Jan1989-June 1990). For these 18 months we use the traditional U.S. market, size, value and momentum factors instead.

3. Main results

In this section we present our main empirical findings. We first describe our overall results, followed by results for the separate countries. We then investigate if our results are robust to restricting the universe to a sample containing only large-cap stocks, to controlling for possible loadings on the value effect and to extending the holding period to up to five years. We next examine the evolvement of the volatility effect over time by considering subsample results.

3.1 Full-sample results

Our main results are presented in Panel A of Table 1, which contains the results for quintile portfolios sorted on past 3-year volatility. We begin by noting that past risk is strongly predictive for future risk, as the realized volatilities of the quintile portfolios are monotonically increasing from roughly 20 to 30 percent annualized, and their betas against the emerging markets market portfolio from 0.79 to 1.15. Turning to the realized returns of the quintile portfolios, we observe that the raw risk-return relation is inverted, as the top (high-volatility) quintile portfolio underperforms the bottom (low-volatility) quintile portfolio by 4.4 percent per annum geometrically and 2.1 percent per annum arithmetically. As a result, the Sharpe ratio of the bottom (low-volatility) quintile portfolio is over double that of the top (high-volatility) quintile portfolio, at 0.64 versus 0.29. Using regression (1) to adjust the geometric average excess returns for differences in market beta, we find economically and statistically significant 1-factor alphas of -5.4 and +3.5 percent per annum for the top and bottom quintile portfolios, resulting in a top-minus-bottom 1-factor alpha spread of -8.8 percent per annum, with an associated t-statistic of -3.71. As in Blitz and van Vliet (2007), we will refer to this finding as the ‘volatility effect’.

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In Panels B, C and D of Table 1 we show the performance characteristics of quintile portfolios sorted on size, value and momentum respectively. Consistent with the results of Fama and French (1998), Patel (1998), Rouwenhorst (1999) and van der Hart, Slagter and van Dijk (2003) we find clear evidence of size, value and momentum premiums in emerging markets. Based on the 1-factor alphas we conclude that the low-volatility premium is much larger than the size premium, and comparable in magnitude to the value premium.[3] Only the raw momentum premium is larger,

[3] We do not report 3- and 4-factor alphas for the quintile portfolios sorted on size, value and momentum in order to save journal space and because the Q5-minus-Q1 size, value and momentum portfolios represent our SMB, HML and UMD factors for emerging markets, i.e. we would essentially be trying to explain

but it should be noted that, due to its high associated turnover, this premium is likely to be eroded most by transaction costs in practical applications.

In order to examine whether systematic exposures to the size, value and momentum effects may explain some, or perhaps even all, of the performance of portfolios sorted on volatility we also report 3- and 4-factor alphas in Panel A of Table 1, based on running regressions (2) and (3). As described in the methodology section, we use the top-minus-bottom size, value and momentum quintile portfolios as a proxy for the SMB, HML and UMD factors in emerging markets. We observe that the 3-factor alpha is, in fact, very similar to the 1-factor alphas, indicating that systematic size or value exposures do not explain the volatility effect in emerging markets. Only the 4-factor alpha is slightly lower, indicating that some of the alpha may be attributable to implicit loadings on the momentum effect. However, at -5.7 percent the spread remains highly significant, both economically and statistically.

3.2 Results by country

We continue by examining the results per country. For this analysis we only include country-month observations that are based on at least 25 stocks, and we only report results for countries for which this leaves at least 60 monthly return observations (19 out of 30 countries). The remaining (11) countries, which each structurally contains only a small number of stocks, are grouped together and reported as one additional observation. We note that the period that is effectively considered for each country can differ. In Table 2 we report 1-factor alphas for the top-minus-bottom quintile of volatility-sorted portfolios per country, where the market factor is assumed to be the equally-weighted return of only the stocks in the country under consideration, instead of the entire emerging markets universe. We observe that for all but two out of the twenty observations (Mexico and Russia) the 1-factor alphas are negative, and that for half of the observations the 1-factor alphas are even double-digit negative. Not surprisingly, the statistical significance of the alphas is less strong at the level of individual countries, due to the larger influence of stock-specific risk. Still, the 1-factor alphas are statistically significantly negative at the 5% level for over a third of the countries in Table 2. Based on these results we conclude that the volatility effect is generally robust across countries.

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something by itself. As a result, the 3- and 4-factors alphas tend to be much smaller than the 1-factor alphas.

3.3 Results for large-caps only

Bali and Cakici (2008) argue that the negative empirical relation between risk and return is concentrated in small, illiquid stocks, especially the strong negative return of high (idiosyncratic) volatility stocks. We already address this concern by including only constituents of the S&P/IFC Investable Emerging Markets Index in our sample, but in this section we go one step further by conducting a robustness test on the 50% largest stocks within this already liquid universe. Specifically, every month we first rank the stocks in our universe on their free-float adjusted market capitalization, and next remove the 50% smallest stocks from that month's sample. The results for volatility-sorted portfolios based on this large-cap only universe are reported in Table 3. The main effect of removing the smaller stocks from our sample appears to be that the average annual return on the various quintile portfolios drops by around 3-4 percent, indicating that large-cap stocks on average exhibited lower returns than small-cap stocks during this particular sample period. The alphas drop accordingly, but the net effect on the top-minus-bottom quintile alpha spreads is limited. At -9.1 to -7.1 percent per annum, the 1-, 3- and 4-factor alpha spreads for the large-cap only universe remain both economically and statistically highly significant. Based on this finding we conclude that the volatility effect in emerging markets is not concentrated in less liquid small-cap stocks.

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3.4 Is the volatility effect a value effect?

Scherer (2010) argues that the alpha of low-versus-high volatility portfolios in the U.S. equity market is mainly a value effect. Our earlier finding that 3-factor alphas are hardly different from 1-factor alphas already indicated that the value (or size) effect does not explain the performance of volatility-sorted portfolios. Specifically, we found a 1-factor alpha of -8.8% with a t-statistic of -3.71 and a 3-factor alpha -8.2% with a t-statistic of -3.36 for the top-minus-bottom quintile portfolio. However, a limitation of this parametric adjustment is that it implicitly assumes that the value exposure of volatility-sorted portfolios is linear and constant over time. This assumption may not be valid though, as value portfolios are known to have a time-varying beta, with risk going up during recessions and down during expansions; see, e.g., Petkova and Zhang (2005). In order to address this concern we also consider double-sorted portfolios. This non-parametric technique allows us to adjust for possible loadings on other effects *ex ante*, as opposed to merely adjusting estimated alphas *ex post*. Our double-sort approach consists of first sorting stocks, within each country, into five portfolios on their value characteristics, next sorting the stocks within each of these five portfolios into five sub-portfolios based on their past 3-year volatility, and finally merging the five lowest volatility sub-portfolios, the five next lowest volatility sub-portfolios, etc., thereby obtaining five new volatility-sorted portfolios which are designed to be not only country neutral, but also *ex ante* value neutral.

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The results, reported in Table 4, do not differ much from our base-case results. In fact, the 1-, 3- and 4-factor alpha spreads of the portfolios sorted first on value and then on volatility are even slightly larger than the alpha spreads of portfolios sorted only on volatility (-9.0 to -6.8 percent versus -8.8 to -5.7 percent). Also, the alphas of the top quintile portfolio of high-volatility stocks remain consistently negative, the alphas of the bottom quintile portfolio of low-volatility stocks remain consistently positive, and the magnitude of both effects remains statistically and economically significant. We conclude that the volatility effect in emerging markets is a distinct effect, which cannot be explained by either explicit or implicit loadings on the well-known value effect.

3.5 Results for longer holding periods

Amenc, Martellini, Goltz and Sahoo (2011) argue that the negative relation between risk and return is only present in the short run, and that over longer holding periods the relation does turn positive as predicted by theory. In order to address this concern we analyze the performance characteristics of volatility-sorted portfolios over holding periods up to 5 years. Specifically, if the holding period is assumed to be N months we calculate the return in month t by taking the unweighted average return of the portfolios formed in the N most recent months, as in Jegadeesh and Titman (1993, 2001). The results are summarized in Table 5. We observe that the 1-factor alphas for the top and bottom quintile portfolio decrease as the holding period increases, but only very gradually. The annualized alpha spread, which starts at -8.8 percent with a 1-month holding period, drops to -7.3 percent with a 1-year holding period and -6.3 percent with a 3-year holding period. Even when the holding period is extended to 5 years the alpha spread remains economically and statistically significant at -4.4 percent per annum. We conclude that the volatility effect is highly persistent and not only present at short investment horizons.

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3.6 Subsample results

Emerging markets can help shed new light on the different hypotheses which have been proposed in the literature to rationalize the apparently anomalous empirical relation between risk and return. Some, such as Black (1993), Frazzini and Pedersen (2010), Hong and Sraer (2012) and de Giorgi and Post (2011) attribute the effect to constraints on leverage or short-selling. The presence of leverage constraints prevents return-seeking investors from taking a levered position in low-risk stocks, and constraints on short-selling prevent arbitrageurs from correcting the inflated prices of high-risk stocks. Others have argued that various agency effects involved with delegated portfolio management fuel the anomaly. One such agency explanation is that delegated portfolio managers are typically evaluated on their return relative to some pre-specified benchmark index, as a result of which they will rationally bid up the price of high-risk stocks and ignore low-risk stocks. Brennan (1993) predicts a flattening of the security market line as a result of this behavior, while Falkenstein (2009) and Blitz (2012) argue that delegated portfolio management may even cause the risk-return relation to become entirely flat. Baker and Haugen (2012) suggest a second agency explanation for the volatility effect, arguing that delegated portfolio managers prefer high-volatility stocks in order to maximize the value of their option-like incentive contracts. A third agency explanation is that profit-maximizing fund management firms prefer high-beta funds because of asymmetric fund-flow patterns, with most of the inflows being attracted by funds with the highest return in rising markets; see, for example, Karceski (2002). The last two explanations can explain why the relation between volatility and expected stock returns may even become negative, instead of merely flat. Emerging markets are an interesting test case, as due to their rapid growth and progressive liberalization over the past decades, they have grown from a niche into a mainstream asset class for global institutional investors. If the volatility effect is primarily caused by agency issues involved with delegated portfolio management, one would expect the effect to have become stronger over time in these increasingly institutionalized markets.

In Table 6 we therefore examine the development of the volatility effect over time by considering the performance of volatility-sorted portfolios over the first and second half of our sample (i.e., the periods 1989 to 1999 and 2000 to 2010 respectively). We believe that simply splitting our sample halfway is most appropriate in light of the limited available total data history for emerging markets, to ensure a certain minimum length for the subperiods, and to avoid data-mining. We note that most of the country crises in emerging markets (e.g., Mexico 1994, Asia 1997 and Russia 1998) are concentrated in the first half of our sample, while some notable global crises (e.g. the burst of the IT bubble in 2000-2002 and the credit crisis from 2008 onwards) are present in the second half of our sample. We observe that the raw relation between risk and return appears to be flat over the first half of our sample, while turning strongly negative over the second half of our sample. This is also reflected in the alpha spreads, which are less than half their full-sample average over the first period, and almost double their full-sample average over the second period. For example, the 1-factor alpha spreads amount to -3.1 and -14.4 percent respectively. A formal difference-in-means test indicates that this difference is statistically significant (*p*-value 0.0047). These findings are consistent with Blitz and van Vliet (2007), who find that also in developed markets the volatility effect appears to have grown stronger over time, and consistent with the hypothesis that agency issues involved with delegated portfolio management contribute to the volatility effect.

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3.7 Choice of risk measure

In this section we examine the robustness of our findings to our choice of risk measure. In Panel A of Table 7 we show results when using past 12- or 60-month volatility, instead of 36-month volatility as used up to this point of our study. In Panel B of Table 7 we additionally show results for past 20-, 120- and 1300-day volatility. Because of the limited availability of daily data this analysis is conducted on the post-2000 period only. For all volatility measures we impose that at least half of the required return observations are available. The results indicate that our findings are highly robust to our choice of volatility measure. All raw Q5-minus-Q1 return spreads are negative, all 1-factor alphas are negative, and all 1-factor alphas are statistically significant.

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In an additional robustness we look at portfolios sorted on past 36-month beta or MAD, as defined in the methodology section, instead of volatility. These results are also reported in Panel A of Table 7. For portfolios sorted on past beta we observe directionally similar, but less strong results compared to the results for portfolios sorted on past volatility. The raw relation between risk and return appears to be flat rather than inverted. The 1-factor alpha spread of -5.6 percent per annum remains economically and statistically significant (with a t-statistic of -2.39), but is smaller than the corresponding spread for volatility-sorted portfolios. Our results are consistent with Rouwenhorst (1999), who observes that beta is not related to return in emerging markets over the 1982 to 1997 period, and also in line with Blitz and van Vliet (2007) and Baker, Bradley and Wurgler (2011), who find that, also in developed equity markets, portfolios sorted on volatility exhibit larger alpha spreads than portfolios sorted on beta. The results for portfolios sorted on MAD are closer to our base-case results for portfolios sorted on volatility, indicating that the volatility effect is also robust to using this alternative risk measure.

4. Global perspective

In this section we consider the volatility effect in emerging markets from a global perspective. First we apply international asset pricing tests, and next we examine if the volatility effects in emerging and developed equity markets are driven by a common component.

4.1 International asset pricing tests

The use of local versions of the 1-, 3- and 4-factor models, similar to for example Rouwenhorst (1998) and Ang, Hodrick, Xing and Zhang (2009), allows us to determine whether the volatility effect in emerging markets is distinct from the size, value and momentum effects that have previously been established for these markets. In a robustness test we additionally examine whether the volatility effect in emerging markets remains significant from a global asset pricing perspective. For this analysis we apply the International CAPM of Fama and French (1998) and its 3-factor and 4-factor extensions, as described in the methodology section. The results are summarized in Table 8.

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Our first observation is that the alphas increase across the board. This can be explained by the fact that the emerging markets universe itself already exhibits a positive alpha when evaluated against the global asset pricing models. Looking at the top-minus-bottom quintile results we observe that this effectively largely cancels out, and that the level of the alphas as well as their significance is similar to the corresponding figures using local factor models, as reported in Table 1. We therefore conclude that also from a global asset pricing perspective there remains a statistically significant volatility effect exists in emerging markets.

4.2 Is there a global volatility effect?

Rouwenhorst (1998) finds that the returns on international and U.S. momentum strategies are correlated, and interprets this is as evidence that exposure to a common factor may drive the profitability of such strategies. In this section we examine the correlation between the volatility effect in emerging equity markets, as documented in this paper, and the previously documented volatility effect in developed equity markets. For this analysis we construct volatility-sorted long-short portfolios for the U.S., European and Japanese markets following the approach of Blitz and van Vliet (2007), i.e. using a survivorship-bias free sample of FTSE World Developed Index constituent stocks. The only difference is that instead of calculating past 3-year volatilities using weekly data, we use monthly data, similar to the analysis of the volatility effect for emerging markets in this paper.

<<< INSERT TABLE 9 ABOUT HERE >>>

Table 9 exhibits the estimated correlation coefficients between the 1-factor alphas of top-minus-bottom quintile volatility portfolios in the various regions over the full sample period from 1989 to 2010. The correlation between the volatility effects in emerging and developed equity markets is moderately positive, at 0.26 with the U.S., 0.19 with Europe and 0.24 with Japan.[4] These findings suggest that the volatility effect in emerging markets is largely independent from the volatility effect in developed markets. Further evidence for this is provided in Table 10, in which we formally test whether the 1-factor alpha of the top-minus-bottom quintile volatility portfolio in emerging markets can be explained by the alphas of the corresponding volatility portfolios in the U.S., Europe and Japan. Following Rouwenhorst (1998) we use a multi-factor regression approach for this. The results indicate that although two out of the three estimated coefficients are statistically significant, the alpha remains large unexplained at -6.9%. These results argue against a common-factor explanation, i.e. the possibility that the volatility effect might reflect a global systematic risk factor. For the value and momentum effects in emerging markets, van der Hart, de Zwart and van Dijk (2005) have previously argued against risk-based explanations as well. For investors the practical implication of the low observed correlation levels is that significant diversification benefits can be achieved by exploiting the volatility effect in multiple markets simultaneously.

<<< INSERT TABLE 10 ABOUT HERE >>>

5. Summary

In this paper we have documented the clear presence of a volatility effect in emerging markets. Contrary to the predictions of theoretical models such as the CAPM, which postulate that the

[4] Correlations are somewhat higher over the more recent 2000-2010 sub-period, but never exceed 0.36.

relation between risk and return should be positive, we find that the empirical relation between risk and return in emerging equity markets is flat, or even negative, in particular for portfolios of stocks sorted on past volatility. Our findings are consistent with studies which have previously established the existence of a volatility effect in the U.S. and other developed equity markets. The volatility effect in emerging markets is found to be robust to considering a universe of large-cap stocks only, to considering longer holding periods and to controlling for exposures to the size, value and momentum effects. The volatility effect also appears to have strengthened over time, which we argue might be related to the increased institutionalization of emerging markets in combination with the agency issues involved with delegated portfolio management. Finally, we find low correlations between the volatility effects in emerging and developed equity markets, which argues against a common-factor explanation.

Having established that the volatility effect is not only present in the U.S. and other developed equity markets but also in emerging equity markets, the empirical evidence for the phenomenon is now quite compelling. In our view, the most interesting area for future research is to develop and apply tests for better distinguishing between the different hypotheses that have been put forward in the literature for rationalizing the persistent existence of a volatility effect.

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Table 1: Emerging Markets Portfolios Sorted on Volatility, Beta and Other Factors

At the end of each month between December 1988 and December 2010, all S&P/IFC Investable Emerging Markets Index constituent stocks at that point in time are sorted into quintile portfolios based on their past 3-year monthly local return volatility (Panel A), log U.S. dollar free-float market capitalization (Panel B), book-to-market ratio (Panel C) or past 12-minus-1 month total return (Panel D). All portfolios are equally weighted and constructed in a country neutral manner, with Q1 containing stocks with the lowest scores and Q5 stocks with the highest scores. The universe is defined as the equally-weighted portfolio of all stocks in the S&P/IFC Investable Emerging Markets Index. We next calculate portfolios returns in U.S. dollars over the subsequent month and repeat the process. For each portfolio we report the annualized arithmetic (simple) and geometric (compounded) mean returns in excess of the U.S. dollar risk-free return, standard deviation, Sharpe ratio, CAPM beta, CAPM alpha and related Newey-West adjusted t-statistics. For the volatility-sorted portfolios we additionally report the annualized 3- and 4-factor alphas and their Newey-West adjusted t-statistics, using the equally-weighted universe as a proxy for the market factor and the top-minus-bottom size, value and momentum quintile portfolios as proxies for the SMB, HML and UMD factors. All alphas are based on the geometric average returns. Statistical significance at the 10%, 5% and 1% levels is denoted by *, ** and *** respectively.

Panel A: Portfolios sorted on volatility

	Q1	Q2	Q3	Q4	Q5	Q5-Q1	Universe
Mean (simple)	15.3%	15.6%	16.0%	16.5%	13.2%	-2.1%	15.5%
Mean (compounded)	13.1%	12.9%	12.6%	12.6%	8.7%	-4.4%	12.2%
Standard deviation	20.5%	23.2%	25.6%	27.6%	29.9%	13.5%	25.1%
Sharpe	0.64	0.56	0.49	0.46	0.29	-0.32	0.49
Beta	0.79	0.91	1.00	1.08	1.15	0.37	1.00
1-factor alpha	3.5%	1.7%	0.4%	-0.6%	-5.4%	-8.8%	-
(t-value)	2.66***	2.08**	0.42	-0.84	-3.68***	-3.71***	-
3-factor alpha	3.8%	2.1%	0.6%	-0.8%	-4.4%	-8.2%	-
(t-value)	2.59***	2.35**	0.50	-1.10	-2.97***	-3.36***	-
4-factor alpha	2.9%	1.7%	0.4%	-0.2%	-2.8%	-5.7%	-
(t-value)	2.03**	1.79*	0.27	-0.19	-1.92*	-2.48**	-

Panel B: Portfolios sorted on size

	Q1	Q2	Q3	Q4	Q5	Q5-Q1	Universe
Mean (simple)	19.0%	15.6%	14.3%	14.5%	14.2%	-4.8%	15.5%
Mean (compounded)	15.1%	12.3%	10.9%	11.3%	11.1%	-3.9%	12.2%
Standard deviation	27.6%	25.1%	25.9%	24.9%	24.5%	11.6%	25.1%
Sharpe	0.54	0.49	0.42	0.45	0.45	-0.34	0.49
Beta	1.07	0.99	1.02	0.98	0.95	-0.12	1.00
1-factor alpha	2.0%	0.3%	-1.6%	-0.7%	-0.4%	-2.4%	-
(t-value)	1.24	0.27	-1.89*	-0.75	-0.35	-0.91	-

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Table 1 (continued)

Panel C: Portfolios sorted on book-to-market

	Q1	Q2	Q3	Q4	Q5	Q5-Q1	Universe
Mean (simple)	11.6%	12.1%	13.0%	16.9%	23.1%	11.5%	15.5%
Mean (compounded)	8.7%	9.0%	9.7%	13.5%	18.9%	10.2%	12.2%
Standard deviation	24.0%	24.7%	25.7%	25.7%	28.3%	12.2%	25.1%
Sharpe	0.36	0.36	0.38	0.53	0.67	0.83	0.49
Beta	0.91	0.95	1.00	0.99	1.08	0.18	1.00
1-factor alpha	-2.4%	-2.6%	-2.5%	1.4%	5.6%	8.0%	-
(t-value)	-1.57	-2.42**	-2.25**	1.37	3.74***	3.65***	-

Panel D: Portfolios sorted on 12-1 month momentum

	Q1	Q2	Q3	Q4	Q5	Q5-Q1	Universe
Mean (simple)	11.1%	15.9%	15.3%	15.2%	19.9%	8.8%	15.5%
Mean (compounded)	6.8%	12.5%	12.1%	12.4%	16.6%	9.8%	12.2%
Standard deviation	29.1%	25.7%	25.3%	23.3%	25.0%	14.4%	25.1%
Sharpe	0.23	0.49	0.48	0.53	0.66	0.68	0.49
Beta	1.12	1.01	0.99	0.91	0.95	-0.17	1.00
1-factor alpha	-6.9%	0.1%	0.0%	1.3%	5.0%	11.8%	-
(t-value)	-3.80***	0.14	0.03	1.30	3.11***	3.75***	-

Table 2: Volatility Effect for Individual Countries

We follow the same methodology as used to construct Table 1, but instead of reporting results for the broad emerging markets universe, we report results for individual countries. To be included a country should have at least 60 monthly data points that are each based on at least 25 stocks. The 11 (out of 30) countries which do not meet this threshold are grouped together and reported as one additional observation. The table reports Q1 to Q5 and Q5 minus Q1 excess returns, 1-factor alphas and related t-statistics calculated against local market returns, defined as the equally-weighted return of only the stocks in the country under consideration.

						Q5 - Q1		
	Q1	Q2	Q3	Q4	Q5	raw return	1-factor alpha	*t-value*
Argentina	-0.6%	-9.6%	-6.0%	-13.0%	-22.9%	-22.3%	-17.6%	-1.78*
Brazil	20.5%	20.3%	12.5%	20.7%	8.7%	-11.8%	-11.9%	-1.18
Chile	10.5%	9.8%	3.8%	6.2%	7.5%	-3.0%	-5.3%	-1.19
China	17.0%	12.5%	18.7%	11.5%	-1.2%	-18.2%	-21.8%	-3.20***
Egypt	-12.9%	-4.5%	-6.4%	-12.6%	-36.0%	-23.1%	-19.3%	-2.73***
Greece	14.1%	11.7%	18.5%	10.5%	1.0%	-13.1%	-16.4%	-1.92*
India	7.9%	9.9%	11.4%	6.2%	-2.9%	-10.8%	-15.7%	-2.33**
Indonesia	0.0%	-2.8%	-3.0%	1.5%	-5.7%	-5.8%	-5.9%	-0.73
Israel	11.6%	8.3%	10.0%	2.6%	-0.8%	-12.4%	-15.7%	-2.79***
Korea	2.8%	4.7%	6.3%	2.8%	-11.1%	-13.9%	-14.4%	-2.51**
Malaysia	5.4%	2.3%	2.3%	-0.8%	-9.3%	-14.7%	-15.2%	-3.46***
Mexico	5.0%	7.1%	7.1%	9.9%	10.3%	5.2%	1.3%	0.29
Philippines	-32.8%	-32.4%	-26.7%	-41.9%	-52.7%	-19.8%	-6.9%	-0.67
Poland	3.3%	4.1%	8.9%	-0.3%	-4.1%	-7.4%	-8.0%	-1.16
Russia	8.6%	24.5%	23.7%	16.7%	19.8%	11.2%	3.6%	0.32
South Afric	9.1%	9.8%	8.7%	10.3%	3.6%	-5.5%	-6.9%	-1.03
Taiwan	-0.4%	-1.0%	-3.6%	-7.1%	-2.6%	-2.2%	-1.4%	-0.32
Thailand	0.2%	3.0%	-1.4%	-5.7%	-11.9%	-12.0%	-11.1%	-1.92*
Turkey	16.2%	12.9%	13.8%	13.7%	16.6%	0.4%	-3.2%	-0.53
Others	11.6%	8.9%	12.4%	10.2%	11.1%	-0.5%	-4.4%	-1.20

Table 3: Volatility Effect among the 50% Largest Stocks

We follow the same methodology as used to construct Table 1, but instead of considering the entire S&P/IFC Investable Emerging Markets Index, we show results based on the 50% largest stocks in this index. Specifically, every month we first rank the stocks in our universe on their free-float adjusted market capitalization, and next remove the 50% smallest stocks from that month's sample.

	Q1	Q2	Q3	Q4	Q5	Q5-Q1	Universe
Mean (simple)	11.1%	12.1%	12.8%	14.1%	9.2%	-1.9%	11.9%
Mean (compounded)	9.1%	9.6%	9.9%	10.5%	4.8%	-4.3%	9.0%
Standard deviation	20.0%	22.4%	23.7%	26.5%	29.9%	14.0%	24.0%
Sharpe	0.46	0.43	0.42	0.40	0.16	-0.31	0.38
Beta	0.72	0.84	0.89	1.01	1.11	0.39	1.00
1-factor alpha	0.3%	-0.7%	-1.0%	-1.8%	-8.8%	-9.1%	-
(t-value)	0.14	-0.39	-0.66	-1.01	-3.64***	-4.11***	-
3-factor alpha	0.9%	0.3%	-0.5%	-1.1%	-6.7%	-7.6%	-
(t-value)	0.60	0.23	-0.38	-0.73	-3.09***	-3.42***	-
4-factor alpha	0.1%	-0.3%	-1.2%	-1.4%	-7.0%	-7.1%	-
(t-value)	0.08	-0.21	-0.84	-0.95	-3.21***	-3.15***	-

Table 4: Double Sort on Value and Volatility

We follow the same methodology as used to construct Table 1, but instead of considering single-sorted portfolios, we consider portfolios that are double sorted on value and volatility. Our double-sort approach consists of first sorting stocks, within each country, into five portfolios on their book-to-market ratio, next sorting the stocks within each of these five portfolios into five sub-portfolios based on their past 3-year volatility, and finally merging the five lowest volatility sub-portfolios, the five next lowest volatility sub-portfolios, etc., thereby obtaining five new volatility-sorted portfolios which are designed to be not only country neutral, but also *ex ante* value neutral. All portfolios are equally weighted and constructed in a country neutral manner, with Q1 containing stocks with the lowest scores and Q5 stocks with the highest scores.

	Q1	Q2	Q3	Q4	Q5	Q5-Q1	Universe
Mean (simple)	16.8%	16.3%	16.1%	17.3%	13.7%	-3.0%	15.5%
Mean (compounded)	14.0%	13.4%	12.9%	13.5%	9.1%	-4.9%	12.2%
Standard deviation	22.9%	23.6%	25.2%	27.2%	30.3%	12.7%	25.1%
Sharpe	0.61	0.57	0.51	0.50	0.30	-0.38	0.49
Beta	0.84	0.91	0.98	1.06	1.16	0.32	1.00
1-factor alpha	3.7%	2.2%	0.9%	0.4%	-5.1%	-8.7%	-
(t-value)	1.93*	2.02**	1.01	0.47	-3.35***	-3.33***	-
3-factor alpha	4.3%	2.0%	0.7%	0.1%	-4.7%	-9.0%	-
(t-value)	1.71*	1.57	0.65	0.09	-2.88***	-3.03***	-
4-factor alpha	3.3%	1.8%	1.3%	1.1%	-3.6%	-6.8%	-
(t-value)	1.59	1.29	0.93	1.08	-2.18**	-2.69***	-

Table 5: Longer Holding Periods

We follow the same methodology as used to construct Table 1, but instead of showing results based on a 1-month holding period, we show results over N-month holding periods for N = 1, 6, 12, 24, 36, 48 and 60. We do so by calculating every month the unweighted average return of the portfolios formed in the N most recent months, as in Jegadeesh and Titman (1993, 2001). The table reports 1-factor alphas and related t-statistics, using the equally-weighted universe as a proxy for the market factor.

Holding period	Q1	Q2	Q3	Q4	Q5	Q5-Q1
1 month	3.5%	1.7%	0.4%	-0.6%	-5.4%	-8.8%
(t-value)	2.66***	2.08**	0.42	-0.84	-3.68***	-3.71***
6 months	2.5%	1.4%	-1.5%	-1.5%	-6.0%	-8.5%
(t-value)	2.29**	1.37	-1.25	-1.30	-3.51***	-3.78***
12 months	2.5%	2.1%	-2.0%	-1.0%	-4.7%	-7.3%
(t-value)	2.15**	1.79*	-1.29	-0.78	-2.51**	-3.18***
24 months	2.5%	1.7%	-1.3%	-1.6%	-3.8%	-6.4%
(t-value)	1.86*	1.01	-0.77	-1.02	-1.83*	-2.79***
36 months	2.9%	1.7%	-0.7%	-0.8%	-3.4%	-6.3%
(t-value)	1.86*	0.92	-0.38	-0.45	-1.58	-2.86***
48 months	2.4%	1.7%	-0.2%	-0.1%	-2.7%	-5.1%
(t-value)	1.49	0.93	-0.09	-0.04	-1.26	-2.46**
60 months	2.2%	1.3%	-0.3%	0.3%	-2.2%	-4.4%
(t-value)	1.33	0.70	-0.16	0.14	-0.99	-2.18**

Table 6: Sub-sample Results

We follow the same methodology as used to construct Table 1, but instead of showing full-sample results, we show results for two sub-periods, 1989-1999 and 2000-2010.

Panel A: 1989-1999

	Q1	Q2	Q3	Q4	Q5	Q5-Q1	Universe
Mean (simple)	14.3%	13.8%	14.6%	17.2%	15.2%	0.8%	15.3%
Mean (compounded)	11.9%	11.0%	11.3%	13.6%	11.4%	-0.5%	12.2%
Standard deviation	21.6%	23.2%	25.2%	26.3%	27.1%	12.0%	24.3%
Sharpe	0.55	0.47	0.45	0.52	0.42	-0.04	0.50
Beta	0.84	0.93	0.99	1.06	1.05	0.21	1.00
1-factor alpha	1.7%	-0.4%	-0.7%	0.7%	-1.4%	-3.1%	-
(t-value)	0.80	-0.27	-0.36	0.53	-0.70	-0.99	-
3-factor alpha	2.5%	0.2%	-0.4%	0.3%	-0.8%	-3.2%	-
(t-value)	1.12	0.11	-0.19	0.27	-0.37	-1.02	-
4-factor alpha	2.8%	0.6%	-0.3%	0.7%	-0.6%	-3.4%	-
(t-value)	1.28	0.44	-0.10	0.52	-0.30	-1.15	-

Panel B: 2000-2010

	Q1	Q2	Q3	Q4	Q5	Q5-Q1	Universe
Mean (simple)	16.2%	17.5%	17.4%	15.8%	11.2%	-5.0%	15.6%
Mean (compounded)	14.3%	14.7%	14.0%	11.7%	6.1%	-8.2%	12.3%
Standard deviation	19.5%	23.2%	26.2%	28.8%	32.4%	14.9%	25.9%
Sharpe	0.73	0.64	0.53	0.41	0.19	-0.55	0.47
Beta	0.74	0.89	1.01	1.11	1.24	0.50	1.00
1-factor alpha	5.2%	3.8%	1.6%	-1.9%	-9.2%	-14.4%	-
(t-value)	5.04***	4.62***	3.07***	-2.87***	-6.02***	-5.93***	-
3-factor alpha	4.7%	3.3%	1.1%	-2.0%	-8.2%	-12.9%	-
(t-value)	4.63***	3.75***	1.68*	-3.17***	-4.78***	-4.94***	-
4-factor alpha	2.7%	2.1%	0.3%	-1.3%	-5.8%	-8.5%	-
(t-value)	2.87***	2.35**	0.38	-1.70*	-3.64***	-3.73***	-

Table 7: Choice of Volatility Measure

We follow the same methodology as used to construct Table 1, but using alternative risk measures. In Panel A we consider portfolios sorted on past 12-month or past 60-month instead of past 36-month volatility, as well as portfolios sorted on past 36-month beta or past 36-month mean absolute deviation (MAD). The past beta of a stock is calculated by regressing its monthly total returns in local currency on that of the S&P/IFC Investable index for the country to which the stock belongs. The past MAD of a stock is also calculated on its monthly total returns in local currency. We consider the full sample period from 1989 to 2010 for these analyses. Panel B shows additional results for portfolios sorted on past 20-, 120- or 1300-day volatility, but due to data limitations only for the 2000 to 2010 sub-period. The table reports Q1 to Q5 and Q5 minus Q1 excess returns, 1-factor alphas and related t-statistics.

Panel A: 1989-2010

						Q5 - Q1		
	Q1	Q2	Q3	Q4	Q5	raw return	1-factor alpha	*t-value*
12M volatility	9.7%	11.9%	13.6%	11.7%	9.4%	-0.3%	-5.0%	-2.17**
36M volatility	13.1%	12.9%	12.6%	12.6%	8.7%	-4.4%	-8.8%	-3.71***
60M volatility	12.4%	12.3%	13.8%	10.4%	7.6%	-4.8%	-8.9%	-3.61***
36M CAPM beta	11.3%	14.1%	10.6%	12.0%	10.3%	-1.0%	-5.6%	-2.39**
36M MAD	12.6%	12.0%	11.3%	12.8%	9.8%	-2.8%	-7.0%	-3.28***

Panel B: 2000-2010

						Q5 - Q1		
	Q1	Q2	Q3	Q4	Q5	raw return	1-factor alpha	*t-value*
20D volatility	12.5%	13.3%	13.6%	11.6%	7.0%	-5.5%	-10.4%	-4.71***
120D volatility	13.9%	14.7%	12.6%	10.5%	5.8%	-8.0%	-14.7%	-5.38***
1300D volatility	14.9%	13.6%	14.6%	11.1%	4.9%	-10.0%	-15.9%	-6.48***

Table 8: International Asset Pricing Models

We follow the same methodology as used to construct Table 1, but instead of using the local emerging markets proxies for the market, size, value, and momentum factors to calculate alpha, we use the global market, size, value, and momentum factors from the data library of Kenneth French. The universe alpha and beta are calculated against the global market factor.

	Q1	Q2	Q3	Q4	Q5	Q5-Q1	Universe
Mean (compounded)	13.1%	12.9%	12.6%	12.6%	8.7%	-4.4%	12.2%
Standard deviation	20.5%	23.2%	25.6%	27.6%	29.9%	13.5%	25.1%
Sharpe	0.64	0.56	0.49	0.46	0.29	-0.32	0.49
Beta	0.90	1.06	1.15	1.28	1.36	0.46	1.17
1-factor alpha	7.3%	6.1%	5.2%	4.4%	0.0%	-7.3%	4.7%
(t-value)	1.75*	1.42	1.11	0.92	0.00	-2.82***	1.33
3-factor alpha	4.6%	3.5%	2.4%	1.3%	-2.3%	-7.0%	-
(t-value)	1.20	0.88	0.54	0.29	-0.48	-2.95***	-
4-factor alpha	5.6%	5.4%	4.7%	3.8%	1.2%	-4.4%	-
(t-value)	1.45	1.36	1.04	0.84	0.24	-1.84*	-

Table 9: Correlation of 1-factor alphas across regions

This table reports the correlation coefficients of 1-factor alphas of top-minus-bottom quintile volatility portfolios in the U.S., European, Japanese and Emerging equity markets. The 1-factors alphas for emerging markets are calculated in the same way as described in Table 1. The 1-factor alphas for the U.S., Europe and Japan are calculated in the same fashion as for emerging markets, but based on FTSE World Developed Index constituent stocks instead. The analysis is based on our full sample period from 1989 to 2010.

	US	Europe	Japan	Emerging
US	1.00			
Europe	0.61	1.00		
Japan	0.17	0.18	1.00	
Emerging	0.26	0.19	0.24	1.00

Table 10: Regression analysis

This table reports the results of an ordinary least squares regression in the spirit of Rouwenhorst (1998) regression of the 1-factor alpha of the top-minus-bottom quintile volatility portfolio in emerging markets on the 1-factor alphas of the top-minus-bottom quintile volatility portfolios in the U.S., Europe and Japan. The 1-factors alphas for emerging markets are calculated in the same way as described in Table 1. The 1-factor alphas for the U.S., Europe and Japan are calculated in the same fashion as for emerging markets, but based on FTSE World Developed Index constituent stocks instead. Reported t-statistics are Newey-West adjusted. The analysis is based on our full sample period from 1989 to 2010.

	Alpha	Beta US	Beta Europe	Beta Japan
coefficient	-6.9%	0.10	0.01	0.10
(t-value)	-3.35***	2.64***	0.23	2.70***

Figure 1: Number of Stocks over Time

This figure plots the number of constituents in the S&P/IFC Investable Emerging Markets Index over our sample period from December 1988 to December 2010.