Volatility and Stock Market Returns around the World

By

Samuel Xin Liang*
Hong Kong University of Science and Technology
Clearwater Bay, Kowloon, Hong Kong
Tel: (852)-9175-8951; Fax: (852) 2358-1749
Email: sxliang@ust.hk

K.C. John Wei
Hong Kong University of Science and Technology
Clearwater Bay, Kowloon, Hong Kong
Tel: (852)-2358-7676; Fax: (852)-2358-1749
Email: johnwei@ust.hk

This draft: August 21, 2006

*We thank Kalok Chan, Roger King, Inchi Hu, Lancelot James, Peter Mackay, Ahron Rosenfeld, Kevin Q. Wang, Chu Zhang, Mungo Wilson, and seminar participants at Hong Kong University of Science and Technology for their helpful comments and suggestions. We acknowledge financial supports from Hong Kong University of Science and Technology. Authors are fully responsible for any errors.

Volatility and Stock Market Returns around the World

Abstract

In this paper, we investigate how idiosyncratic volatility is cross-sectionally related to the expected returns at the stock level and at the market portfolio level across 23 developed countries. We also examine whether international investors are concerned about aggregate volatility risk at the local level and at the global level. We find that local volatility innovation is a priced risk factor for stocks in some countries. We also discover that global volatility innovation is negatively priced for these 23 market portfolios after controlling for global market, value and size factors. In sharp contrast to the stock level, we uncover that both local total volatility and local idiosyncratic volatility have high expected market portfolio returns even after adjusting for these global factors. They dominate these four global factors in explaining market portfolio returns. Supporting Merton's (1987) incomplete information model, this result suggests that idiosyncratic stock volatility can be diversified away when investors hold locally-diversified market portfolios. Global investors are rewarded by high returns for bearing high risk characteristic measured by local volatility in a country.

JEL Classification: G11, G12, G15

Keywords: International, volatility innovation, idiosyncratic volatility, incomplete information

1. Introduction

In recent decades, investors increasingly invest across the globe in order to enjoy higher stock returns and diversification benefits as documented by Giorgio and Gerrard (1997).[1] However, global investors face two levels of risk factors: for stocks at the local level and for market portfolios at the global level. It is critical for investors to know whether there is any additional local and global risk factors in addition to Fama-French's (1992, 1993, and 1998) three factors. In the US market, Ang, Hodrick, Xing, and Zhang (2006a) find that aggregate volatility risk is a negative pricing factor for stocks. They show that stocks with a high sensitivity to this market-level risk have low expected returns. They also find that stocks with high idiosyncratic volatility have low average expected returns. These results also control for the momentum effect of Jegadeesh and Titman (1993) and the impact of Pástor and Stambaugh's (2003) liquidity risk.

The importance of global investment raises three important issues related to volatility on international asset pricing. One is the cross-sectional relation between volatility as a risk characteristic and expected return at both the stock- and market-portfolio level across 23 developed countries. The second issue is whether aggregate volatility innovation is a risk factor for stocks at the local level and for market portfolios at the global level around the world. The last one is whether investors are compensated by higher expected returns for bearing higher risk, as measured by total and idiosyncratic volatility, when they invest in locally-diversified market portfolios. This paper addresses all of these issues.

The pricing of aggregate volatility risk in Ang et al. (2006a) is consistent with Merton's (1973) ICAPM, namely, that market volatility innovation is an investment opportunity set. As Campbell (1993, 1996) and Chen (2002) show, investors would like to hedge against market

[1] In 2005, the second largest market in the world, Japanese market, earn over 35%, and the third largest market, UK market, earn over 25% whilst the largest market, the US market, only earn less than 5%.

volatility innovation since an increase in market volatility reflects deterioration in investment opportunities. However, the finding concerning stock idiosyncratic volatility in Ang *et al*. (2006a) is inconsistent with traditional asset pricing theories. They also show that this second finding is not caused by a stock's exposure to aggregate volatility risk. According to CAPM, investors should be compensated by higher returns for bearing higher risks. Merton's (1987) incomplete information model also argues that idiosyncratic volatility should have higher returns. Because information is costly, investors must pay to gain information about a stock. These information costs should be compensated by stock returns. This second finding also contradicts a recent behavioral model by Barberis and Huang (2001) which predicts that stocks with higher idiosyncratic volatility should have higher expected returns.

Supporting Levy's (1978) Generalized CAPM, Carroll and Wei (1988) find that higher idiosyncratic volatility calculated from monthly returns has higher expected return for the period prior 1986. The disparity in evidence over time regarding idiosyncratic volatility raises three intriguing questions: Are these two different results driven by different measures of idiosyncratic volatility because the stock idiosyncratic volatility in Ang et al. (2006a) is adjusted for daily Fama-French three factors? Does the puzzling phenomenon of stock idiosyncratic volatility in the U.S. market prevail in 23 developed markets? [2,3] In other words, should investors expect to earn higher expected returns when they invest in stocks with higher idiosyncratic volatility across these markets? If not, can stock idiosyncratic volatility be diversified away by investing in market portfolios?

[2] A potential explanation may be the dispersion of investor opinions. However, Peterson and Peterson (1982), Diether, Malloy and Scherbina (2002), and Boehme, Kumar, and Sorescu (2006) find a positive relation between return volatility and the dispersion of investor opinions. Gebhardt, Lee and Swaminathan (2001) use forecast dispersion as a risk proxy for estimating cost of capital and find a significant "wrong sign".

[3] Ang et al. (2006a) use Harvey and Siddique's (2000) measure to show that stock coskewness is not an explanation even though Harvey and Siddique (2000) find that stocks with positive coskewness have lower returns.

If idiosyncratic risk at the stock level can be diversified away, the global CAPM predicts that total volatility of market portfolio (i.e., local total volatility) as a risk characteristic should have high expected returns across different markets.[4] Furthermore, country specific information among international investors should be asymmetric. It will be more costly for global investors to gain information about foreign markets. The idiosyncratic volatility of market portfolio (i.e., local idiosyncratic volatility) reflects asymmetric information about a country. These information costs should be compensated in the form of high expected returns on market portfolios. Therefore, Merton's (1987) incomplete information model also predicts that local idiosyncratic volatility should have high average expected returns.

We measure idiosyncratic volatility at the individual stock level using monthly returns for the past three years. We discover that idiosyncratic volatility has lower expected returns in many of these 23 markets. In a concurrent study, Ang et al. (2006b) extend their analysis to a few other markets using the same measure as in Ang *et al*. (2006a). They find that stocks with high idiosyncratic volatility also have low expected returns in geographic regions and in the aggregate global market. These two international findings imply that this puzzling phenomenon of stock idiosyncratic volatility is not an artifact of measurement methodology. We can also infer that stock idiosyncratic volatility represents an undesirable risk characteristic of a stock around the world.

In stark contrast, we discover that local total volatility and local idiosyncratic volatility command high expected returns even after controlling for global Fama-French three factors. Global investors are rewarded by high returns for bearing country specific risk. In order to ensure that this result is not caused by the artifact of measurement for local idiosyncratic volatility, we also construct local idiosyncratic volatility by idiosyncratic stock volatility as

[4] Industry portfolios and stock portfolios formed on stocks' characteristics are still not fully diversified.

constructed in Ang *et al*. (2006a). We find that this second measure of local idiosyncratic volatility produces the same results. Hence, our findings are robust and consistent with the prediction of Merton's (1987) incomplete information at the global level. This implies that stock idiosyncratic volatility can be diversified away when investors hold market portfolios.

In investigating aggregate volatility risk factor, we find that local volatility innovation is a negatively priced factor for stocks in some countries (Canada, Belgium, Norway, Spain, Switzerland, and the United Kingdom) after controlling for local market, value, and size risk factors[5]. We also find that global volatility innovation is a negatively priced risk factor for these 23 diversified market portfolios even after controlling for global Fama-French three factors. Market portfolios that have a high sensitivity to this global risk will earn low expected returns. Our findings suggest that market volatility innovation at both local and global levels is an investment opportunity set in Merton's (1973) ICAPM. Global investors are concerned about this global risk factor even though they invest in locally-diversified market portfolios through exchange-traded funds (ETFs). In contrast to our empirical evidence at the stock level, market portfolio exposure to this global risk has an opposite impact on market portfolio returns as that of their local volatility.

This raises another important question, namely, whether a market portfolio's sensitivity to global volatility innovation and local volatility can offset each other. If not, which of them dominates? We find that local total volatility dominates both Fama-French three global factors and global volatility risk in explaining market portfolio returns. Local idiosyncratic volatility also dominates these global factors. Our findings suggest that local total volatility and local idiosyncratic volatility are the most important risks in explaining the expected returns of locally-diversified market portfolios.

[5] Fama and French (1998) document that market and value factors are common factors for stocks across several developed countries.

There is limited study into the cross-sectional relation between volatility and stock and market portfolio returns even though time-series stock volatility in the U.S. market has been widely studied.[6] We enrich the limited international literature on cross-sectional relations between volatility and expected stock returns in both local and global levels. We explore the cross-sectional relation between volatility and market portfolio returns because Campbell, Lettau, Malkiel, and Xu (2001) show that market volatility tends to lead industry volatility and individual stock volatility. Our results have critical implications for international investors. They can earn higher expected returns for bearing higher risk exposure when they invest in locally-diversified market portfolios. As our local idiosyncratic volatility captures the risk of incomplete information in Merton (1987)'s shadow cost, our findings also contribute to our understanding about the international home bias puzzle. Bernanke and Rogoff (2000) propose that this puzzle is attributed by the asymmetric information between foreign and home investors.

The remainder of the paper is organized into seven sections. Section II describes the data. Section III outlines theoretical motivations. Section IV presents our volatility measures. Section V provides our empirical results at the country level. Section VI, conducts an analysis at the global level. In Section VII, we show that local volatility dominates market portfolios' returns. Section VIII concludes.

2. Data Sample

In this study, we have selected 23 countries that are classified as developed countries by IMF. Their markets are the constituent markets of the MSCI world index and cover the majority of the world market. These countries are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Greece, Germany, Hong Kong, Italy, Ireland, Japan, Netherland, New Zealand,

[6] Previous studies in volatility include Campbell and Hentschel (1992), Glosten and Runkle (1993), Eraker, Johannes, and Polson (2003), Chacko and Viceira (2004).

Norway, Portugal, Singapore, Spain, Sweden, Switzerland, the United Kingdom and the United States. Their daily total market return indices, market capitalization (size), and exchange rates are retrieved from DataStream for the period January 1975 to June 2005. I convert their returns into US dollar so that investors can measure their investment in the same unit in the global market.

We also retrieve monthly returns and market capitalization of all traded stocks from these countries. We retrieve stock monthly returns and market capitalization from DataStream except for the US market, data of which is from CRSP, for the period from January 1975 to June 2005. When there is no trading volume for a stock in a particular month, we treat it as no trading and delete it from our sample. We then convert all stock and market portfolio returns and market capitalization into US dollar. Investors are exposed to the same exchange rate when they invest in different stocks in the same countries. We perform our empirical tests for the sample period from January 1975 to June 2005. We use the yield on the US treasury bills as the risk free rate when I construct excess return in US dollars for both returns on stocks and market portfolios.

As reported in table 1, we find that Greece has the highest average monthly return and Hong Kong has the second highest return. The US market is the largest market and contains about one-third of stocks in our sample in June 2005. Japan is the second largest market in terms of the number of stocks in our sample. Australia, Canada, Germany, France, Hong Kong, Italy, Netherland, Spain, Switzerland and the United Kingdom are also major markets. Each of Austria, Ireland and Portugal has less than 100 traded stocks in June 2005 in our sample. In particular, Portugal has more than 100 stocks prior to 2003. Many stocks could not survive after 2003 in Portugal.

[Insert table 1 here]

2.1 Local Factors

When testing the pricing of local volatility risk for stocks in each market, we need to construct local factors from stocks in each country. We define local market factor (*MKTX*) as the market portfolio return minus risk free rate in US dollar. We follow Fama and French (1993 and 1998) to construct local size factor (*SMB*) from stock returns in each country. In particular, all traded stocks in a country are firstly sorted into the top 30% (big), the bottom 30% (small), and the medium 40% (medium) based according to their market capitalization at the end of the preceding year. The local size factor is the value-weighted of local small-minus-big portfolio. In a similar way, local value factor (HML_i) is constructed in each country. All stocks in a country are sorted on their book-to-market ratios at the end of preceding year into the top 30% (High), the bottom 30% (Low), and the medium 40% (Medium). The local value factor is the value-weighted return of local high-minus-low portfolio.

In order to empirically test whether local market volatility innovation is a common pricing factor at stock in each market, we need to construct eight country economic portfolios based on stocks' characteristics. They are book-to-market ratios (*BM*), earnings-to-price ratios (*EP*), cash earnings-to-price ratios (*CP*), and dividend yields (*YLD*). All stocks in each of these 23 countries are sorted on these characteristics into the top 30% (High), the low 30% (Low) and the medium 40% (Medium). Our eight country economic tracking portfolios are value-weighted portfolios formed by stocks in the top BM, bottom BM, top EP, bottom EP, top CP, bottom CP, top YLD and bottom YLD.

2.2 Global Factors

To test whether global volatility risk is a common pricing factor, we need to control for the well-documented global market return, size and value factors. The global market factor

(*MKTX*) in US dollar is the value-weighted returns of these 23 market portfolio returns minus the risk free rate. I follow Fama and French (1993, 1998) to construct the global size factor (*SMB*) from market portfolio returns. More specifically, markets are firstly sorted into the top one-third (big), the bottom one-third (small), and the medium one-third (medium) on their market value at the end of the preceding year. The global size factor is the value-weighted return of global small-minus-big (*SMB*) portfolio. Similarly, global value factor (*HML*) is constructed from all stocks around the world. All stocks in the world market are sorted into the top 30% (high), the bottom 30% (low), and the medium 40% (medium) on their book-to-market ratios at the end of the preceding year. Global value factor is the value-weighted return of global high-minus-low (*HML*) portfolio. Local value factors are retrieved from Kenneth French Data Library. To be consistent, we will not estimate the pricing premium for local volatility innovation in Greece and Portugal because Kenneth does not provide the value factor for these markets. Formerly, they were emerging markets and have been recently classified as developed markets by MSCI and the IMF.

In order to test whether global volatility innovation is priced, we also need to construct eight global economic portfolios based on firm characteristics. They are book-to-market ratios (*BM*), earnings-to-price ratios (*EP*), cash earnings-to-price ratios (*CP*), and dividend yields (*YLD*). All of the stocks in these 23 countries are sorted on these characteristics into top 30% (High), low 30% (Low) and medium 40% (Medium). Our eight global economic tracking portfolios are value-weighted portfolios formed by stocks in the top BM, bottom BM, top EP, bottom EP, top CP, bottom CP, top YLD and bottom YLD.

3. Theoretical Motivation

In this section, we will present various theoretical predictions on the cross-sectional relation between volatility and returns at the local level and at the global level. In particular, if a change in aggregate volatility is related to investment opportunity set, it should be priced according to Merton's (1973) ICAPM. We also discuss why the phenomenon of stock idiosyncratic volatility is puzzling according to Merton's (1987) incomplete information model. On the other hand, Miller (1977) analyzes that stock with high idiosyncratic volatility can have low returns when there are short-sell constraints.

3.1 The theoretical prediction for idiosyncratic volatility

Ang *et al.* (2006a) show that stocks with high idiosyncratic volatility have low expected returns. This finding is in line with Miller's (1977) analysis about stock performance under short-sell constraints. However, their empirical tests include all stocks in the US market in the period from January 1963 to December 2000. Short-sell activities have been widely observed in this period. On the other hand, this finding is inconsistent with existing asset pricing theories. Levy (1978) and Malkiel and Xu (2002) extend CAPM and theoretically show that idiosyncratic risk has high expected returns in the cross-section. Merton's (1987) incomplete information model also predicts that stocks with high idiosyncratic volatility should have high returns.

We restate Merton's (1987) equilibrium incomplete information model and its implication on idiosyncratic volatility. This model has a shadow cost with the incomplete information as follows:

$$R_i = \delta\beta_{im} MKTX + \delta w_i \sigma_i^2 / q_i \, , \qquad (1)$$

where δ is the investor preference in his exponential utility function, the w_i is the weight of market portfolio i in the global market, q_i is the fraction of investors who have complete information, and σ_i^2 is the residual variance of idiosyncratic component $\varepsilon_{i,t}$ of asset returns from the following regression after adjusting for the market factor:

$$R_{i,\tau} = \alpha_i + \beta_{i,t-1} MKTX_\tau + \varepsilon_{i,\tau}, \qquad (2)$$

In this equilibrium model, many investors are not fully informed. They spend a great deal of time and effort and costs to gain information regarding a particular stock. Therefore, investors should expect higher compensations for their expenses. This model suggests that stock idiosyncratic volatility should have higher return as it captures the incomplete information among investors. In a similar concept, market information in a country is also asymmetric among home and foreign investors. They also require compensation for their costs to retain information about a particular market. Merton's (1987) incomplete information model predicts that local idiosyncratic volatility should have higher expected market portfolio returns around the world. We therefore investigate how idiosyncratic volatility are cross-sectionally related to expected returns at stock level and at market portfolio level around the world.

3.2 Pricing aggregate volatility risk

Merton's (1973) ICAPM predicted that any investment opportunity set should demand a pricing premium. Campbell's (1993 and 1996) Intertemporal Capital Asset Pricing Model (I-CAPM) shows that investors are concerned about changes in forecasts of market future returns in addition to market return risk. Chen (2002) extends Campbell's model to accommodate time-varying covariances and stochastic market volatility. He shows that assets will have lower expected returns when they have higher covariance with a variable that forecasts market volatility. Campbell (1993 and 1996) and Chen (2002) argue that investors would like to hedge against aggregate volatility innovation. French, Schwert and Stambaugh (1987) and Campbell and Hentschel (1992) also show that market volatility tends to be high when market moves downward. In addition, Bakshi and Kapadia (2003) discover that stocks with high sensitivities to market volatility risk provide hedges against market downside risk. These empirical findings suggest that an increase in market volatility reflects deterioration in investment opportunities. Thus, the aggregate volatility risk can be an undesirable investment opportunity set in Merton's (1973) ICAPM. Recently, Bates (2001) and Vayanos (2004) also provide structural models that volatility risk has a negative risk premium in a reduced form factor structure. Therefore, we expect both local volatility innovation and global volatility innovation should have a negative premium if they are priced.

2.4. Volatility Measure

In this section, we will present how we measure idiosyncratic volatility at the stock level, local total volatility, local idiosyncratic volatility, local volatility innovation and global volatility innovation. We also construct local idiosyncratic volatility as our second measure in the same way as Ang *et al.* (2006a) do in the US market. This is because we would like ensure that our empirical results of local idiosyncratic volatility are not caused by the artifact of measurement and are robust with respect to the measure in Ang *et al.* (2006a).

2.4.1 Stock Idiosyncratic Volatility

Ang *et al.* (2006a) construct idiosyncratic volatility as the standard deviation of residuals in a daily Fama-French three factors model. In order to examine whether their result is driven by their measure, we alternatively construct stock idiosyncratic volatility as the standard deviation of residuals in a monthly Fama-French three factors model. We define stock idiosyncratic volatility ($IVol_{i,j,t-1}$) of stock j in market i as, $\sqrt{\mathrm{var}(\varepsilon_{i,j,t-1})}$, the standard deviation of the idiosyncratic component $\varepsilon_{i,t}$ in equation (2) for the period from month t-36 to month t-1:

$$R_{i,j,\tau} = \alpha + \beta_{i,j,t-1} MKTX_{i,\tau} + \beta_{i,j,t-1} HML_{\tau} + \beta_{i,t-1} SMB_{\tau} + \varepsilon_{i,\tau}, \quad \tau = t-36,..,t-1 \qquad (2)$$

where $R_{i,\tau}$ is market portfolio return excess return at time *τ* in market *i*, *MKTX* is a global market factor that is global market return minus the US treasury T-bill rate, *HML* is global value factor, and *SMB* is global size factor.

2.4.2 Local Total Volatility

As stated in equation (3), we construct our local total volatility of market *i,* $TVOL_{i,t}$, at month *t* as the standard deviation of the daily market portfolio's return , $r_{i,t}$, at month *t* in US dollar.

$$TVOL_{i,t} = \sqrt{Var(r_{i,t})}, \qquad (3)$$

where $Var(r_{i,t})$ is the variance of $r_{i,t}$. This local total volatility measure is the same as the stock's total volatility measure in Ang *et al.* (2006a).

2.4.3 Local Idiosyncratic Volatility

In a similar way as the stock's idiosyncratic volatility in equation (2), we use market portfolios' monthly returns in the past three years to construct our local idiosyncratic volatility, $IVOL_{i,t}$. We just replace stock excess returns with the excess returns of market portfolios and substitute local factors with global factors in equation (2).

4.3.1 Robustness Measure

In order to conduct a robustness check for our study on local idiosyncratic volatility in later section, we construct our second measure for the local idiosyncratic volatility, $IVOL^{II}_{i,t}$. It is the standard deviation, $\sqrt{\text{var}(\varepsilon_{i,t-1})}$, of the daily idiosyncratic component $\varepsilon_{i,t}$ in month *t* from the following regression:

$$R_{i,\tau,t} = \alpha_{i,t} + \beta_{i,t} MKTX_{\tau,t} + \varepsilon_{i,\tau,t},\ \tau = 0,..,D_{t-1} \qquad (4)$$

where $R_{i,\tau,t}$ is the daily market portfolio excess return in market *i* at time *τ* in month *t*, *MKTX* is global market excess return. Ang *et al*. (2006a) document that their stock idiosyncratic volatility adjusted for daily Fama-French three factors has a correlation of 0.99 with the one that is only adjusted for daily market excess return. Hence, our second measure for local idiosyncratic volatility is the same as their stocks' idiosyncratic volatility measure.

4.3.2 Correlation with market portfolio returns

As reported in table 2, we find that Finland has the highest time-series average of local total volatility and Greece has the second highest local total volatility and the highest local idiosyncratic volatility. The simple average of local idiosyncratic volatility is highly correlated with market portfolio return with a value of 0.74 with a t-statistic of 5.05. Our second measure of local idiosyncratic volatility also has high correlation of 0.704 and t-statistic 4.54.[7] This simple summary statistic suggests that markets with higher volatility are cross-sectionally associated with higher portfolio returns. This is in contrast to the puzzling phenomenon of stock volatility in the US market, which is documented by Ang *et al.* (2006a). In addition, the simple averages of local total volatility in both local currency and US dollar are highly correlated with their monthly market portfolios' returns. Their correlations are 0.67 with a t-statistic of 4.16 and

[7] The local idiosyncratic volatility has a 0.95 correlation with its second measures.

0.72 with a t-statistic of 4.70.[8] We will perform a comprehensive empirical study of this matter in later sections.

[Insert table 2 here]

2.4.4. Local volatility innovation

We measure local volatility innovation $\Delta VOL_{i,t}$ in month *t* as the changes in the variance of market portfolio daily return in market *i* in month *t* as stated below:

$$\Delta VOL_{i,t} = Var(r_{i,t}) - Var(r_{i,t-1}), \tag{5}$$

where $r_{i,t}$ is the market portfolio's daily return in month t and $Var(r_{i,t})$ is the variance of $r_{i,t}$. [9]

2.4.5 Global volatility and its innovation

We construct our daily value-weighted global market portfolio return after converting all country market returns and values into US dollar. I then take the global volatility as the standard deviation of the daily global market return. As shown in figure 1, I find that the highest spike of world market volatility which occurred in the "Black October" crash. Meanwhile, the 9.11 attack created the second highest global volatility around the world as it introduced large economic uncertainty around the world. Two Iraq wars and the collapse of LTCM also created very high volatility around the world. The world market had been much more volatile in the period from the Asian financial crisis to the end of economic recession around the in early 21st century than other periods in the history except for "Black October". Therefore, the world stock market became much more sensitive to international events after the globalization of world economy in

[8] Alternatively, we use the standard deviation of the monthly market portfolio returns in the past three years as our second measure for local total volatility. This measure also has a high correlation of 0.708 with a t-statistic of 4.60.

[9] We can also construct our second measure for local volatility innovation measure-II as the changes in the standard deviation of market portfolio's daily return as following: $\Delta VOL^{II}{}_{i,t} = \sqrt{Var(r_{i,t})} - \sqrt{Var(r_{i,t-1})}$.

the late 1990s. We expect that the global market volatility innovation is important to market portfolio returns and global investors around the world. As in equation (4), I construct our global volatility innovation ΔVOL_t as the changes in the variance of daily global market return in month *t*. In the later section, we find that this global volatility innovation demands a negative premium at 23 market portfolios around the world. We do not construct an alternative measure.

[Insert figure 1 here]

2.5. **Volatility and Stock Returns around the World**

We will firstly examine whether the puzzle of idiosyncratic volatility at the stock level prevails across 23 developed countries. We will then investigate whether local volatility innovation is a priced risk factor for stocks in each market. This task will help investors to understand whether local volatility innovation is a risk factor for stocks around the world.

5.1. Stock idiosyncratic volatility and returns

In order to conduct our study at the local level, we sort stocks into five value-weighted portfolios in each country on their stock idiosyncratic volatility in the previous period. I find that stocks with higher idiosyncratic volatility have lower expected returns in most of 23 developed markets. In particular, we construct the zero-cost high-minus-low portfolio that longs stocks with highest idiosyncratic volatility and shorts stocks with lowest idiosyncratic volatility. We find that the abnormal excess returns after controlling country market, value and size factors are generally negative. As reported in table 3, this puzzling phenomenon significantly prevails in Australia, Belgium, France, Hong Kong, Italy, Spain, and the USA.

[Insert table 3 here]

When we form five equally-weighted portfolios, the abnormal excess returns of equal-weighted high-minus-low portfolios are significantly positive in Australia, Canada and Belgium. This suggests that large stocks contribute to this stock level puzzle within these three countries. Meanwhile, the zero-cost hedging portfolio in Japan has an abnormal excess returns that is also significant negative.

In a contemporary study of Ang *et al.* (2006b), they construct stock idiosyncratic volatility using daily return as they did in the US market. They find that stocks with higher idiosyncratic volatility also have lower expected returns in geographic regions and in the aggregate global market. Our findings combined with theirs suggest that the phenomenon of higher stock idiosyncratic volatility with lower expected returns is not due to different constructions of idiosyncratic volatility. The exceptional cases are in Belgium and Canada. My interpretation is that some undesirable characteristics associated with low expected returns might cause this stock idiosyncratic volatility puzzle. In the later section, we will empirically investigate whether this stock idiosyncratic volatility as an idiosyncratic characteristic risk can be diversified away when investors hold market portfolios.[10]

5.2. The mimicking factor of local volatility innovation

We now turn to our study on the whether local volatility innovation is cross-sectionally a common risk factor. Market volatility innovation is not an asset. It thus is not tradable. We follow Breeden, Gibbsons and Litzenberger (1989) and Lamont (2001) to use an economic tracking portfolio that mimics this aggregate volatility risk. We obtain the mimicking factor of local volatility innovation after controlling for the local volatility innovation in the last period as the following AR(1) regression:

[10] It is beyond the scope of this study to find out what the underlying economic reasons drive this puzzling phenomenon at stock level.

Economic Tracking Model:

$$\Delta Vol_{i,t} = \beta_0 + \beta'_F\, MF_{i,t} + \theta \Delta Vol_{i,t-1} + \varepsilon_{i,t}\,, \tag{7}$$

where MF_t is a 8x1 vectors containing eight local economic tracking portfolios that are the high *BM*, low *BM*, high *E/P*, low *E/P*, high *CE/P*, low *CE/P*, high *YD* and low *YD* portfolios. The portfolio weights in (3) do not need to sum to one as documented by Lamont (2001). I define this tradable portfolio *MVol* as the mimicking factor of local volatility innovation in the following:

$$MVol_{i,t} \equiv \beta'_F\, MF_{i,t} \tag{8}$$

where $\beta'_F\, MF_t$ is stated in equation (3). This mimicking factor is the unexpected local volatility innovation because $\theta \Delta Vol_{i,t-1}$ captures the expected part of local volatility innovation.

2.5.3 *The premium for local volatility innovation*

In order to estimate the pricing premium for local volatility in each country, we need to construct stock portfolios that are formed according to their sensitivity to this local risk. This approach will eliminate the clustering effects among individual stocks. We firstly sort stocks into 20 portfolios in each country on their past betas of the mimicking factor of local volatility innovation. We obtain stocks' *past beta* $\beta^v_{i,j}$ in country market *i* by running following regression (8) for the period from month *t-60* to month *t-1*.

$$R_{i,j,\tau} = \alpha_i + \beta^m_{i,j} MKTX_{i,\tau} + \beta^h_{i,j} HML_{i,\tau} + \beta^s_{i,j} SMB_{i,\tau} + \beta^{MVOL}_{i,j} MVol_{i,\tau} + \varepsilon_{i,j,\tau} \tag{9}$$

where $R_{i,j,\tau}$ is stock's excess return *j* in country *i* at time τ, $MKTX_{i,\tau}$ is country market excess return at time τ, $HML_{i,\tau}$ is country value factor at time τ, $SMB_{i,\tau}$ is country size factor at time τ, $MVol_{i,\tau}$ is this country market volatility innovation mimicking risk factor at time τ.

We then estimate the time-series betas of these four local factors for these 20 stock portfolios from equation (8) by substituting stock excess returns with portfolio excess returns. We use these 20 equally-weighted portfolios to perform the following Fama-Macbeth regression to investigate whether the mimicking factor is priced for stocks in each country.

$$R_{i,t} = \psi_0 + \psi_m \beta_{i,t-1}^{m} + \psi_h \beta_{i,t-1}^{h} + \psi_s \beta_{i,t-1}^{s} + \psi_v \beta_{i,t-1}^{MVOL} + \eta_{i,t} \ , \qquad (10)$$

where $\beta_{i,t-1}^{m}$ is portfolio's market beta, $\beta_{i,t-1}^{h}$ is portfolio's value beta, $\beta_{i,t-1}^{s}$ is portfolio's size beta, and $\beta_{i,t-1}^{v}$ is portfolio's beta of the mimicking factor of local volatility innovation. As reported in table 4, we find that the local volatility innovation is a common pricing factor in Spain and the United Kingdom in addition to the US market. [11]

[Insert table 4 here]

Investors and stocks may behave differently in various markets. We can alternatively estimate the pricing premium for the mimicking factor of local volatility innovation by other stock portfolios in each market. We can estimate a stock's direct sensitivity to local volatility innovation from the following regression for the period from month *t-60* to month *t-1*.

$$R_{i,j,\tau} = \alpha_i + \beta_{i,j}^{m} MKTX_{i,\tau} + \beta_{1,i,j}^{v} VOL_{i,\tau} + \beta_{2,i,j}^{v} VOL_{i,\tau-1} + \varepsilon_{i,j,\tau} \ . \qquad (11)$$

We define a stock *j*'s market volatility innovation beta as $\beta_{\Delta vol,i,j}^{v} = \beta_{1,i,j}^{v} + \beta_{2,i,j}^{v}$. I then form 20 equally-weighted stock portfolios on this beta, $\beta_{\Delta vol,i,j}^{v}$. We then obtain the time-series betas of four local factors for these 20 stock portfolios from equation (8) by replacing stock excess returns with portfolio excess return. We also perform Fama-MacBeth regression in equation (9) to estimate the pricing premium for the local volatility innovation. We find that it is a common pricing risk factor for stocks in Belgium, Norway, and Switzerland. In addition, we also find that

[11] We find that the aggregate volatility risk is also negatively priced in US market when we measure it as the changes in the standard deviation of market portfolio return.

it also negatively priced at the 20 value-weighted stock portfolios in Canada. Its negative premium is -0.06 with a t-statistic of -1.90.[12] Overall, local volatility innovation risk is a common risk factor for stocks in some of these 23 developed markets. Investors should be concerned about this risk when investing in stocks in these particular markets.

2.6. Volatility and Market Portfolio Returns around the World

We now turn our study toward the cross-sectional relation between volatility and market portfolio returns at the global level. We previously find that stocks with higher idiosyncratic volatility generally have lower expected returns in most developed markets. We now investigate whether this undesirable stock idiosyncratic volatility can be diversified away. If it does, we expect that market portfolios with higher total volatility should have higher returns. We know that local volatility represents individual characteristic risk in a country. The prices and returns of options on market indices depend on it. The local idiosyncratic volatility captures idiosyncratic risk components of a market after adjusting for its exposure to global factors. Information about different markets is asymmetric among international investors. Investors expect compensation for their cost and effort in collecting a market's information. According to Merton's (1987) incomplete information model, we expect that market portfolios with higher local idiosyncratic volatility will have higher returns.

We then investigate whether global volatility innovation is a common risk factor at market portfolios around the world. If it is, investors are interested in knowing whether a market portfolio's exposure to this global risk has the same directional impact on market portfolio

[12] We can find that the local value factor is priced at these different stock portfolios in Australia, Austria, Belgium, Canada, Denmark, Finland, Germany, Italy, Japan, Norway, and the USA. The local size factor is also priced at these different stock portfolios in Australia, Finland, and Germany when we test these four local factors at the same time.

returns as the local volatility does. If it does not, investors are concerned about which one can dominate.

6.1. Local total volatility and market portfolio return

We construct local total volatility using the daily return of market portfolio in both US dollar and local currency. This local total volatility measure is the same as the stock total volatility measure in Ang et al. (2006a). We then sort market portfolios into three portfolios on their total volatility in the previous month. We find an increasing raw return pattern. The abnormal excess returns of these equal-weighted portfolios also have a clear monotonic increasing trend even after controlling for global market, value, and size factors. As stated in table 5, the abnormal excess returns of the high-minus-low hedging portfolio are 0.66 with a t-value of 3.46, 0.67 with a t-value of 3.44, and 0.67 with a t-value of 3.41 when market portfolio total volatility is constructed from its daily returns in US dollar. It is interesting to note that the capitalization of portfolios sorted according to this total volatility is strictly decreasing in volatility ranking. When we construct market total volatility from daily returns in local currency, the abnormal excess returns are 0.69 with a t-value of 3.36, 0.71 with a t-value of 3.40, and 0.72 with a t-value of 3.40. These two results are robust since we find a similar result when we construct local total volatility using past three-month returns.

[Insert table 5 here]

Our finding is consistent with asset pricing theory such as world CAPM. But it is contrast to the evidence in stock level in US market documented by Ang et al. (2006a). This implies that stock idiosyncratic volatility, as an undesirable characteristic risk, can be diversified away. In order to further investigate this matter, we now turn to conduct our study of the local idiosyncratic volatility at the global level.

6.2. Local idiosyncratic volatility and market portfolio returns

We sort market portfolios into three equally-weighted portfolios on their local idiosyncratic volatility estimated from equation (2). As reported in table 6, the abnormal excess returns of the post-ranking portfolios also have a strictly monotonic increasing trend. The zero-cost hedging portfolio that longs the highest ranking portfolio and sorts the lowest ranking portfolio also has significant abnormal excess returns. The abnormal excess returns of the hedging portfolio are 0.54 with a t-value of 2.93, 0.50 with a t-value of 2.67, and 0.48 with a t-value of 2.49.

[Insert table 6 here]

6.2.1 Robustness Check

We also sort market portfolios into three portfolios on their local idiosyncratic volatility obtained in equation (4). This local idiosyncratic volatility measure is the same as the stock idiosyncratic volatility measure in Ang et al. (2006a). We discover that local idiosyncratic volatility have strictly higher raw returns. We also find that local idiosyncratic volatility has higher expected abnormal excess returns even after controlling for global market, value and size factors. As reported in table 7, these abnormal returns have a strictly monotonic increasing trend over the local idiosyncratic volatility ranking. The zero-cost hedging portfolio also has significant abnormal excess returns. They are 0.95 with a t-value of 5.11, 0.94 with a t-value of 4.91, and 0.92 with a t-value of 4.81.

[Insert table 7 here]

Our results empirically support Merton's (1987) incomplete information model at the global level. They are robust for both our local idiosyncratic volatility measures. This further confirms that local idiosyncratic volatility has higher expected returns. Again, stocks' idiosyncratic volatility can be diversified away when investors hold locally diversified market portfolios.[13]

2.6.3 The pricing for global volatility innovation

We now turn to investigate whether global volatility innovation is a common risk factor at market portfolio returns. We construct the mimicking factor of global volatility innovation by replacing local volatility innovation with global volatility innovation and substitute eight local tracking portfolios with eight global tracking portfolios in equations (7) and (8).

6.3.1 Portfolios sorted on past betas of the mimicking factor of global volatility innovation

We also estimate the past betas, β_i^v , of market portfolio *i* to the global mimicking factor in equation (9). We can then sort market portfolios into three portfolios on their past beta. There will be enough market portfolios in each ranked portfolio[14]. The portfolio high (H) has the highest past beta of global mimicking factor and the portfolio low (L) has the lowest past beta of global mimicking factor. We obtain abnormal excess returns of equally-weighted portfolios from the following models:

$$R_{i,t} = \alpha_i^k + \sum_{j=1}^{J} \beta_{i,j} F_{j,t} + \varepsilon_{i,t}, \quad i = 1,..,N, \tag{12}$$

where $F_{j,t}$ is global factor *j*, which is one of the global market excess return-*MKTX*, the global value factor-*HML*, and the global size factor-*SMB.*

[13] In order to finding economic reasons for why this idiosyncratic puzzle exists at stock level, I will rely on future research.

[14] In particular, there are less than 16 countries in the data sample before 1988. We find similar results when we sort markets into four portfolios.

We find that these abnormal excess returns have a monotonic decreasing trend. The high-minus-low zero-cost hedging portfolio that longs the portfolio with the highest past betas and shorts the portfolio with the lowest past betas also has a abnormal excess return that is significant negative. As reported in table 8, they are -0.40 with a t-value -1.76, -0.50 with a t-value -2.19, and -0.53 with a t-value -2.34. We can infer that a market portfolio exposure to this global risk will lead to a lower expected return. We can also apply Campbell's (1993 and 1996) and Chen's (2002) results to the global setting that an increase in global volatility will also lead to a decrease in investment opportunity. According to Merton's (1973) ICAPM at global level, our previous finding suggests that global mimicking factor should be negatively priced at diversified country market portfolios.

[Insert table 8 here]

6.3.2 The pricing premium for global volatility innovation

We follow traditional asset pricing methodology to perform Fama-MacBeth regression in equation (10) by replacing the stock portfolios' past betas with 23 market portfolios' past betas. As shown in table 9, we find that global market volatility innovation mimicking risk significantly demands a negative premium at market portfolios for the period from January 1976 to June 2005. The negative pricing premium is monthly -1.37 with a t-value of -1.91.[15] This finding suggests that the global volatility innovation provides hedging property. It is a global risk that demands negative premium at locally diversified market portfolios. This shows that it is an undesirable investment opportunity set in Merton (1973) in the global market.

[Insert table 9 here]

[15] The mimicking factor of global volatility innovation is significantly priced with a value of -1.23 and a t-statistic of -1.72 when we construct the global size factor using market portfolio returns instead of stocks around the world.

2.7. The Dominant Nature of Local Volatility

Our prior results show that a market portfolio's exposure to global volatility innovation has an opposite impact on market portfolio returns, similar to the local volatility. It is important and interesting for global investors to know how local volatility as a characteristic competes with the mimicking factor of global volatility innovation as a global factor on market portfolio returns. An extended question is whether one of these two forces can dominate market portfolios' expected returns. In this section, we empirically reveal our understanding of these matters.

7.1. Two dimensional forces

We firstly sort market portfolios into three portfolios according to their last period volatility then into three portfolios on their past betas to the mimicking factor. We find that the high-minus-low zero-cost hedging portfolio sorted on local total volatility consistently has higher abnormal excess returns. But, we find that the effect of global volatility innovation cannot significantly demand lower returns after controlling for market volatility.[16] On the other hand, we still find that local total volatility has higher abnormal returns even after additionally controlling for global volatility innovation. We now use econometric methods to investigate how these two different economic forces have impacted on market portfolio returns.

7.2. The dominant nature of local total volatility

In order to obtain our objectives, we follow Daniel, Titman, and Wei (2001) to perform Fama-Macbeth regressions (11):

[16] The abnormal excess returns of zero-cost hedging portfolio are still negative.

$$R_{i,t} = \psi_0 + \sum_{j=1}^{M} \psi_\beta \beta^j_{i,t-1} + \psi_{vol} Vol_{i,t-1} + \varepsilon_{i,t}\,, \qquad (11)$$

where $\beta^j_{i,t-1}$ is market portfolio *i's* return past beta to global factor *j* that is one of global market, value and size factors, and global market volatility innovation risk mimicking factor, and $Vol_{i,t-1}$ is market portfolio *i's* total volatility in previous month *t-1*. These four types of betas are previously obtained in regression (9) when all of them are in the regression (11). The betas of global Fama-French factors are estimated in equation (2) when I conduct our studies for these three betas only.

As reported in table 10, I find that local total volatility significantly dominates diversified portfolio market returns with a coefficient of 0.88 with a t-value of 3.18 over global Fama-French three factors. It also dominates market portfolio returns with a coefficient of 1.32 and a t-statistic of 4.12 even additionally controlling for the global volatility innovation risk. At the same time, their past betas are no longer significant at 10% level. Going one step further, an important and interesting question is whether local idiosyncratic volatility also exhibits this nature.

[Insert table 10 here]

2.7.3 The dominate nature of local idiosyncratic volatility

We investigate whether market portfolio idiosyncratic volatility also dominates locally diversified market portfolio returns by the following Fama-MacBeth regression:

$$R_{i,t} = \psi_0 + \sum_{j=1}^{M} \psi_\beta \beta^j_{i,t-1} + \psi_{vol} IVol_{i,t-1} + \varepsilon_{i,t}\,, \qquad (12)$$

where $IVol_{i,t-1}$ is last-period market portfolio *i's* idiosyncratic volatility stated in equation (2), and betas of global factors are the same as in equation (11).

As shown in table 11, I find that local idiosyncratic volatility dominates these four global factors in explaining market portfolio expected returns with a coefficient of 0.23 with a t-value of 3.03. Note that the idiosyncratic component is independent to market factors' betas. But, the standard deviation of this idiosyncratic component, as its second moment, is not independent to these betas. In particular, we independently regress local idiosyncratic volatility on market, value and size betas, and find that their coefficients are 0.17 with a t-value 15.16, 0.06 with t-value 5.14, and 0.29 with a t-value 26.30.

[Insert table 11 here]

We also perform the above Fama-MacBeth regression by replacing the local idiosyncratic volatility with our local idiosyncratic volatility measure-II. That is estimate in equation (4). In particular, it has a coefficient of 0.99 and a t-statistic of 3.58 when we control for global Fama-French three factors. Its coefficient is 1.22 with a t-statistic 4.05 when we additionally control for betas of global volatility innovation.

Our results are robust for both local idiosyncratic volatility measures. These results suggest that the most important risk to diversified market portfolio returns is the country market risk. Our result in local idiosyncratic volatility strengthen our previous economic argument that stock idiosyncratic volatility can be diversified away when investors hold locally diversified portfolio. Investors can be compensated with higher expected market portfolio returns for bearing higher country market risks. A market portfolio's idiosyncratic volatility is a country specific characteristic risk in global version of Merton's (1987) incomplete information model. Because local idiosyncratic volatility captures the risk of incomplete information in Merton (1987)'s shadow cost $\delta w_i \sigma_i^2 / q_i$, this finding also contributes to our understanding towards the international home bias puzzle. Bernanke and Rogoff (2000) economically propose that this puzzle is attributed by the asymmetric information among foreign and home investors. We empirically support their economical argument.

8. Conclusion

We find that the local volatility innovation is a priced risk factor for stocks in some large developed markets in addition to the US market. At the global level, we discover that global volatility innovation significantly demands a negative premium for market portfolios among 23 developed countries even after controlling for global market, value and size factors. In particular, market portfolios with higher sensitivity to this global risk will have lower expected returns even after controlling for these global factors. This finding confirms that the global volatility innovation is an undesirable opportunity set in Merton (1973) model. Investors should be concerned about the volatility innovation at both local and global levels when they invest in stocks and locally-diversified market portfolios in domestic and foreign markets around world.

We also find that stocks with higher idiosyncratic volatility have lower expected returns in most of 23 developed markets. This result together with the findings in Ang *et al*. (2006a) and Ang *et al*. (2006b) is not consistent with traditional asset pricing theory such as Merton's (1987) incomplete information model. This also implies that stock idiosyncratic volatility captures an undesirable idiosyncratic risk.

In sharp contrast to stock level, we discover that both local total volatility and local idiosyncratic volatility have higher expected market portfolio returns even after controlling for global Fama-French three factors. We can infer that the undesirable idiosyncratic volatility risk can be diversified away when investors hold in locally-diversified market portfolios. Global investors can earn higher compensations for bearing higher characteristic risks in the global level. This result is consistent with asset pricing theories such as the global CAPM and Merton's (1987) incomplete information model in the global setting.

In addition, we discover that both local total volatility and local idiosyncratic volatility dominates global volatility innovation and global Fama-French three factors on market portfolio returns. Our results are robust because we measure local idiosyncratic volatility in two different ways. Our findings suggest that both local total volatility and local idiosyncratic volatility are the most important risks in explaining locally-diversified market portfolio returns. Local idiosyncratic volatility reflects asymmetric information in Merton's (1987) shadow cost among international investors. Our findings provide economic understanding of the international home bias puzzle as Bernanke and Rogoff (2000) argue that this puzzle is due to the asymmetric information among foreign and home investors.

References

[1] Ang, Andrew, and J. Chen, 2002, Asymmetric correlations of equity portfolios, *Journal of Financial Economics*, 63, 3, 443-494.

[2] Ang, Andrew, Robert J. Hodrick, Yuhang Xing and Xiaoyan Zhang, 2006a, The cross-section of volatility and expected returns, *Journal of Finance* 61,249-276.

[3] Ang, Andrew, Robert J. Hodrick, Yuhang Xing and Xiaoyan Zhang, 2006b, Higher idiosyncratic volatility and lower expected stock returns: An international evidence, working paper, Cornell University.

[4] Baily, Warren, Y. Peter Chung, 1995, Exchange rate fluctuations, political risk, and stock returns: Some evidence from an emerging market, *Journal of Financial Quantitative and Analysis* 30, 541-561.

[5] Barberis, N., and M. Huang, 2001, Mental accounting, loss aversion, and individual stock returns, *Journal of Finance*, 56, 4, 1247-1292.

[6] Bates, David, 2006, The market for crash risk, NBER working paper, University of Iowa.

[7] Bakshi, G., and N. Kapadia, 2003, Delta-hedged gains and the negative market volatility risk premium, Re*view of Financial Studies*, 16, 2, 527-566.

[8] Bernanke, Ben S. and Kenneth Rogoff, 2000, Six major puzzles in international macroeconomics: Is there a common cause?, NBER Macroeconomics Annual, (Cambridge: MIT Press). 339-390.

[9] Boehme, Rodney D., Bartley R. Danielsen, Praveen Kumar, and Sorin M. Sorescu, 2006, Idiosyncratic risk and the cross-section of stock returns: Merton (1987) meets Miller (1977), working paper, University of Houston.

[10] Campbell, John Y., 1993, Intertemporal asset pricing without consumption data, *American Economic Review*, 83, 487-512.

[11] Campbell, John Y., 1996, Understanding risk and return, *Journal of Political Economy*, 104, 298-345.

[12] Campbell, John Y., and L. Hentschel, 1992, No news is good news: An asymmetric model of changing volatility in stock returns," *Journal of Financial Economics*, 31, 281-318.

[13] Campbell, John Y., M. Lettau, B. G. Malkiel, and Y. Xu, 2001, Have individual stocks become more volatile? An empirical exploration of idiosyncratic risk," *Journal of Finance*, 56, 1, 1-44.

[14] Carroll, Carolyn and K.C. John Wei, 1988, Risk, return, and equilibrium: An extension, The *Journal of Business*, 61, 4, 486-499.

[15] Chen, Joseph S., 2002, Intertemporal CAPM and the cross-section of stock returns, working paper, University of South California.

[16] Chacko, George, and Luis M. Viceira, 2004, Dynamic consumption and portfolio choice with stochastic volatility in incomplete markets, *Review of Financial Studies*, forthcoming.

[17] Diether, Karl B., Christopher J. Malloy and Anna Scherbina, 2002, Differences of opinion and the cross-section of stock returns, *Journal of Finance* 57, 2113-2141.

[18] Dumas, Bernard and Bruno Solnick, 1995, The world price of foreign exchange risk, *Journal of Finance* 50, 2, 445-479.

[19] Geert Bekaert, and Harvey, Campbell, 1995, Time-varying world market integration, *Journal of Finance*, 50, 2, 403-444.

[20] Geert Bekaert, and Harvey, Campbell, 1997, Emerging equity market volatility, *Journal of Financial Economics*, 43, 29-78.

[21] Eraker, B., M. Johannes, and N. Polson, 2003, The Impact of jumps in volatility and returns, *Journal of Finance*, 58, 3, 1269-1300.

[22] Daniel, Kent, Sheridan Titman, and K.C. John Wei, 2001, Explaining the cross-section of stock returns in Japan: factors or characteristics?, *Journal of Finance* 56, 743-766.

[23] Fama, Eugene F., and Kenneth R. French, 1992, The cross-section of expected stock returns, *Journal of Finance* 47, 427–465.

[24] Fama, Eugene F., and Kenneth R. French, 1993, Common risk factors in the returns on stocks and bonds, *Journal of Financial Economics* 33, 3–56.

[25] Fama, Eugene F., and Kenneth R. French, 1995, Size and book-to-market factors in earnings and returns, *Journal of Finance* 50, 131–156.

[26] Fama, Eugene F., and Kenneth R. French, 1998, Value versus growth: International evidence, *Journal of Finance* 53, 1975-1999.

[27] Fama, Eugene. F., and J. D. MacBeth, 1973, Risk, return, and equilibrium: Empirical tests, *Journal of Political Economy* 71, 607-636.

[28] French, K. R., G.W. Schwert, and R. F. Stambaugh, 1987, Expected stock returns and volatility," *Journal of Financial Economics*, 19, 3-29.

[29] Glosten, L. R., R. Jagannathan, and D.E. Runkle, 1993, On the relation between the expected value and the volatility of the nominal excess return on stocks, *Journal of Finance*, 48, 5, 1779-1801.

[30] Giorgio, de Satis and Bruno Gerrard, 1997, International asset pricing and portfolio diversification with time-varying risk, *Journal of Finance* 50, 5, 1881-1921.

[31] Harvey, Campbell R., and Akhtar Siddique, 2000, Conditional skewness in asset pricing tests, *Journal of Finance*, 55, 3, 1263-1295.

[32] Harvey, Campbell, and Wayne Ferson, 1993, The risk and predictability of international equity returns, *Review of Financial Studies,* 6, 527- 566.

[33] Jegadeesh, Narasimhan., and Titman, Sheridan, 1993, Returns to buying winners and selling losers: implications for stock market efficiency, *Journal of Finance* 48, 65-91.

[34] Lamont, Owen. A., 2001, Economic tracking portfolios, *Journal of Econometrics*, 105, 1, 161-184.

[35] Levy, H., 1978, Equilibrium in an imperfect market: A constraint on the number of securities in the portfolio, *American Economic Review* 68, 643–658.

[36] Malkiel, Burton G., and Yexiao Xu, 2004, Idiosyncratic risk and security returns, working paper, University of Texas at Dallas.

[37] Merton, Robert. C., 1973, An intertemporal capital asset pricing model, *Econometrica* 41, 867-887.

[38] Merton, Robert. C., 1987, A simple model of capital market equilibrium with incomplete information, *Journal of Finance*, 42, 3, 483-510.

[39] Pástor, Lubos., and Robert F. Stambaugh, 2003, Liquidity risk and expected stock returns, *Journal of Political Economy* 111, 3, 642-685.

[40] Peterson P.P. and D.R. Peterson, 1982, Divergence of opinion and return, *Journal of Financial Research*, 5, 125-134.

[41] Richards, Anthony J., 1996, Winner-loser reversals in national stock market indices: Can they be explained?, *Journal of Finance* 52,2129-2144

[42] Rouwenhorst, K. Geert, 1998, International momentum strategies, *Journal of Finance* 53, 1, 267-284.

Table 1: Summary statistic of data sample

This table reports the summary statistic of the data sample. The market capitalization is total market value in billion US dollar in June 2005. The number of traded stocks is the total number of actively traded stocks in June 2005. The monthly return is the simple time-series average of monthly market portfolio return. The sample period is from January 1976 to June 2005.

Country	Market capitalization in June 2005	Number of traded stocks in June 2005	Monthly return
Australia	648.09	1015	1.58%
Austria	97.36	93	1.00%
Belgium	239.23	234	1.23%
Canada	986.33	1175	1.15%
Denmark	146.92	165	1.46%
Finland	173.23	139	1.69%
France	1426.44	808	1.56%
Germany	1073.72	838	0.93%
Greece	101.12	298	2.53%
Hong Kong	705.16	745	2.08%
Ireland	97.58	50	1.96%
Italy	743.86	273	1.75%
Japan	3335.53	2759	0.54%
Netherland	597.85	143	1.30%
New Zealand	38.10	126	0.99%
Norway	142.54	151	1.58%
Portugal	65.49	57	0.87%
Singapore	166.79	341	1.13%
Spain	616.74	140	1.29%
Sweden	323.69	328	1.78%
Swiss	806.46	322	1.01%
UK	2667.30	1186	1.71%
US	13324.74	6686	1.18%

Table 2: Summary statistic of market portfolio volatility

This table reports the summary statistic of market portfolio volatility. The market portfolio volatility is the standard deviation of the daily market portfolio return times $\sqrt{250/12}$. The market portfolio idiosyncratic volatility measure of market *i* is $\sqrt{250/12}$ times the standard deviation of the idiosyncratic component $\varepsilon_{i,t}$ from the following regression:

$$R_{i,\tau} = \alpha + \beta_{i,t-1} MKTX_{\tau} + \varepsilon_{i,\tau}, \quad \tau = 0,..,D_{t-1},$$

where *MKTX* is the daily global market excess return and D_{t-1} is the number of trading day in month *t-1*. The market portfolio idiosyncratic volatility measure-II of market *i* is the standard deviation of the idiosyncratic component $\varepsilon_{i,t}$ from the following regression:

$$R_{i,\tau} = \alpha + \beta_{i,t-1}(MKTX_{\tau}) + \beta_{i,t-1} HML_{\tau} + \beta_{i,t-1} SMB_{\tau} + \varepsilon_{i,\tau}, \quad \tau = t-36,..,t-1,$$

where *MKTX* is the monthly global market excess returns, *HML* is the monthly global value factor, and *SMB* is the monthly global size factor. The sample period is from January 1976 to June 2005. The t-statistic for correlation is in parentheses.

Country	Volatility in US dollar	Volatility in local currency	Idiosyncratic volatility measure	Idiosyncratic volatility measure-II
Australia	4.85%	3.98%	4.50%	4.49%
Austria	4.29%	2.83%	4.52%	3.25%
Belgium	4.86%	3.30%	3.83%	3.38%
Canada	3.54%	3.25%	3.13%	2.98%
Denmark	5.04%	3.88%	4.36%	3.81%
Finland	8.14%	7.00%	6.67%	5.87%
France	5.78%	4.64%	4.15%	3.73%
Germany	5.10%	3.90%	3.41%	3.13%
Greece	7.58%	6.73%	8.83%	6.55%
Hong Kong	6.93%	6.74%	6.90%	5.90%
Ireland	5.29%	4.20%	4.60%	4.21%
Italy	6.24%	5.35%	5.61%	4.71%
Japan	4.95%	4.06%	3.83%	3.80%
Netherland	5.49%	4.03%	3.16%	3.18%
New Zealand	4.97%	4.00%	4.61%	4.64%
Norway	6.37%	5.51%	5.24%	4.91%
Portugal	4.71%	3.40%	3.99%	3.27%
Singapore	5.23%	4.87%	5.24%	4.62%
Spain	5.83%	4.57%	3.82%	3.46%
Sweden	6.27%	5.38%	5.31%	4.40%
Swiss	5.08%	3.28%	2.23%	2.15%
UK	4.96%	4.05%	4.03%	3.49%
US	3.93%	3.93%	2.74%	3.06%
Correlation with return	0.672* (4.16)	0.716* (4.70)	0.740* (5.05)	0.704* (4.54)

Table 3: The alphas of portfolios sorted on stock idiosyncratic volatility in each country

This table reports the abnormal return of the zero-cost H-L stock portfolios from January 1978 to June 2005. Stocks in each country are sorted into five portfolios on their idiosyncratic volatility. The idiosyncratic volatility of stock *j* in market *i* is the standard deviation of the idiosyncratic component $\varepsilon^{j}_{i,\tau}$ from the regression: $R^{j}_{i,\tau} = \alpha_i + \beta^{j}_{m,i,t-1} MKTX_{i,\tau} + \beta^{j}_{h,i,t-1} HML_{i,\tau} + \beta^{j}_{s,i,t-1} SMB_{i,\tau} + \varepsilon^{j}_{i,\tau}$, $\tau = t-36,..,t-1$, where $MKTX_i$, HML_i, and SMB_i are the market excess returns, the value and size factors in market *i*. The zero-cost portfolio H-L longs portfolio with highest stock idiosyncratic volatility (ranked H) and shorts portfolio with lowest stock idiosyncratic volatility (ranked L). In panel A, portfolio's return is value-weighted. In panel B, portfolio's return is equally-weighted. The t-statistic is in parenthesis.

Panel A: Alphas of value-weighted portfolios sorted on stock idiosyncratic volatility

Country	Raw return (H-L)	CAPM (H-L)	Fama-French Two Factors (H-L)	Fama-French Three Factors (H-L)
Australia	-0.08	-0.25	-0.23	-1.43
	(-0.14)	(-0.79)	(-0.39)	(-2.83)
Austria	2.42	1.89	1.36	1.35
	(0.63)	(0.49)	(0.34)	(0.34)
Belgium	-0.38	-0.40	-0.59	-0.50
	(-1.26)	(-1.31)	(-1.98)	(-2.00)
Canada	-0.27	-0.51	-0.42	-0.71
	(-0.54)	(-1.04)	(-0.87)	(-1.48)
Denmark	-0.72	-0.79	-0.76	-0.64
	(-1.35)	(-1.48)	(-1.40)	(-1.17)
Finland	-0.53	0.01	-0.17	-0.34
	(-0.64)	(0.01)	(-0.24)	(-0.50)
France	-0.64	-0.64	-0.66	-0.79
	(-1.74)	(-1.72)	(-1.76)	(-2.14)
Germany	-0.28	-0.25	-0.11	-0.04
	(-0.89)	(-0.79)	(-0.34)	(-0.13)
Hong Kong	-0.83	-0.96	-0.99	-1.72
	(-1.51)	(-1.72)	(-1.78)	(-3.67)
Ireland	-0.33	-0.42	-0.51	-0.53
	(-0.26)	(-0.32)	(-0.38)	(-0.39)
Italy	-1.34	-1.40	-1.40	-1.56
	(-2.61)	(-2.70)	(-2.72)	(-3.44)
Japan	-0.20	-0.26	-0.21	-0.22
	(-0.82)	(-0.82)	(-0.64)	(-0.70)
Netherlands	-0.04	-0.06	-0.19	-0.16
	(-0.08)	(-0.14)	(-0.44)	(-0.40)
New Zealand	0.01	0.03	0.02	-0.59
	(0.16)	(0.04)	(0.03)	(-1.02)
Norway	-0.16	-0.30	-0.40	-0.64
	(-0.28)	(-0.63)	(-0.72)	(-1.20)
Singapore	-0.01	-0.19	-0.26	-0.45
	(-0.01)	(-0.39)	(-0.55)	(-0.99)
Spain	-0.88	-0.93	-0.92	-0.74
	(-2.18)	(-2.27)	(-2.19)	(-1.81)
Sweden	0.48	0.48	0.29	0.07
	(0.92)	(0.92)	(0.57)	(0.15)
Swiss	-0.17	-0.18	-0.26	-0.26
	(-0.57)	(-0.58)	(-0.88)	(-0.87)
UK	-0.27	-0.33	-0.35	-0.59
	(-0.66)	(-0.80)	(-0.84)	(-1.59)
US	-0.44	-1.02	-0.37	-0.82
	(-1.05)	(-2.83)	(-1.13)	(-3.49)

Table 3 continue:

Panel B: Alphas of equal-weighted portfolios sorted on stock idiosyncratic volatility

Country	Raw return	CAPM (H-L)	Fama-French Two Factors (H-L)	Fama-French Three Factors(H-L)
Australia	3.38	3.13	3.51	1.08*
	(4.04)	(3.65)	(4.07)	(1.85)
Austria	7.36	6.94	6.35	6.36
	(1.69)	(1.58)	(1.43)	(1.43)
Belgium	1.26	1.23	1.12	1.12*
	(4.11)	(4.12)	(3.67)	(3.69)
Canada	2.60	2.22	2.29	1.66*
	(4.59)	(4.19)	(4.33)	(3.38)
Denmark	0.21	0.04	0.07	-0.01
	(0.50)	(0.11)	(0.16)	(-0.02)
Finland	0.42	0.24	0.23	0.13
	(0.56)	(0.32)	(0.31)	(0.17)
France	0.85	0.74	0.69	0.53
	(2.71)	(2.36)	(2.21)	(1.76)
Germany	0.03	-0.07	-0.01	0.09
	(0.12)	(-0.24)	(-0.03)	(0.36)
Hong Kong	-0.06	-0.07	-0.07	-0.98*
	(-0.11)	(-0.14)	(-0.14)	(-3.04)
Ireland	-0.09	-0.14	-0.26	-0.30
	(-0.12)	(-0.17)	(-0.32)	(-0.37)
Italy	0.17	0.14	0.14	0.05
	(0.46)	(0.38)	(0.37)	(0.14)
Japan	-0.22	-0.31	-0.50	-0.52*
	(-0.88)	(-1.28)	(-2.07)	(-2.36)
Netherlands	0.39	0.26	0.17	0.19
	(1.19)	(0.78)	(0.53)	(0.73)
New Zealand	1.68	1.57	1.55	0.56
	(2.46)	(2.32)	(2.27)	(0.91)
Norway	1.11	0.86	0.81	0.47
	(2.05)	(1.59)	(1.54)	(1.00)
Singapore	0.17	-0.03	-0.12	-0.35
	(0.41)	(-0.09)	(-0.31)	(-1.03)
Spain	-0.39	-0.59	-0.45	-0.24
	(-0.72)	(-1.10)	(-0.80)	(-0.43)
Sweden	0.86	0.60	0.59	0.04
	(1.06)	(0.74)	(0.72)	(0.06)
Swiss	0.08	0.05	-0.07	-0.06
	(0.32)	(0.18)	(-0.28)	(-0.27)
UK	0.24	0.12	0.08	-0.15
	(0.80)	(0.40)	(0.26)	(-0.61)
US	0.38	-0.12	0.43	-0.02
	(0.90)	(-0.31)	(1.19)	(-0.07)

Table 4: The premium for the mimicking factor of local volatility innovation

This table reports the premium for the mimicking factor of local volatility innovation. It is estimated by Fama-MacBeth regressions using 20 equally-weighted stock portfolios in each country for the period from January 1980 to June 2005. Stocks are sorted into 20 portfolios on their betas of the mimicking factor. The betas, $\beta^{j}_{mvol,i,t-1}$, of stock *j* are from the regression:

$$R^{j}_{i,\tau} = \alpha_i + \beta^{j}_{m,i,t-1} MKTX_{i,\tau} + \beta^{j}_{h,i,t-1} HML_{i,\tau} + \beta^{j}_{s,i,t-1} SMB_{i,\tau} + \beta^{j}_{mvol,i,t-1} MVOL_{i,\tau} + \varepsilon^{j}_{i,\tau}, \ i = 1,..,23, \ \tau = t-60,..,t-1,$$

where $MKTX_i$, HML_i, and SMB_i are the market, value and size factors in market *i*. $MVol_{i,t}$, the mimicking factor is the $\beta'_{i,F} MF_i$ from the economic tracking model $\Delta Vol_{i,t} = \beta_{i,0} + \beta'_{i,F} MF_{i,t} + \theta_i \Delta Vol_{i,t-1} + \varepsilon_{i,t}$, where *MF* is the 8x1 vector of eight country economic tracking portfolios. $\Delta Vol_{i,t-1}$, the local volatility innovation is the change in the variance of daily market portfolio return. The eight economic tracking portfolios are the value-weighted return on the high (top 30%) book-to-market portfolio, the value-weighted return on the low (bottom 30%) book-to-market portfolio, the value-weighted return on the high (top 30%) earnings-to-price portfolio, the value-weighted return on the low (bottom 30%) earnings-to-price portfolio, the value-weighted return on the high (top 30%) cash earnings-to-price portfolio, the value-weighted return on the low (bottom 30%) cash earnings-to-price portfolio, the value-weighted return on the high (top 30%) dividend yield portfolio, the value-weighted return on the low (bottom 30%) dividend yield portfolio.

Country	β^{MKTX}	t-value	β^{HML}	t-value	β^{SMB}	t-value	β^{MVol}	t-value
Australia	-0.37	-0.17	0.14	0.18	1.74	1.39	0.10	0.13
Austria	0.83	0.58	-0.85	-0.28	-0.43	-1.49	1.20	1.17
Belgium	-4.69	-1.56	1.18	0.77	4.89	2.03	0.05	0.53
Canada	-2.74	-0.79	0.63	0.75	2.16	1.40	-0.02	-0.19
Denmark	-1.57	-1.98	1.17	1.03	0.78	-0.98	0.09	0.81
Finland	1.07	0.90	0.89	0.79	0.90	0.81	0.06	0.22
France	0.53	0.55	-0.64	-0.76	-0.12	-0.23	-0.06	-0.82
Germany	0.74	1.06	0.69	1.23	-0.37	-0.76	-0.05	-0.75
Hong Kong	0.72	0.84	0.22	0.36	-0.86	-1.31	-0.12	-0.73
Ireland	0.19	1.04	-0.17	-0.93	-0.10	-1.10	-0.01	-0.02
Italy	1.32	1.02	1.01	2.18	0.23	0.42	0.01	0.60
Japan	-0.49	-0.58	-0.12	-0.25	0.70	1.33	-0.02	-0.38
Netherlands	0.08	0.10	-1.84	-1.86	-0.76	-1.32	-0.09	-1.28
New Zealand	0.22	0.20	-0.85	-0.71	-0.17	-0.22	0.16	0.18
Norway	1.45	1.46	-1.45	-1.18	0.13	0.17	0.07	0.36
Singapore	-0.52	-0.83	-0.79	-1.16	0.39	1.03	0.99	0.90
Spain	-1.14	-1.23	-0.07	-0.12	-0.15	-0.32	-0.86	-1.96
Sweden	0.24	0.13	-1.35	-0.90	0.66	0.90	0.29	1.00
Swiss	-0.57	-0.31	-2.95	-1.08	-0.98	-1.17	0.37	0.79
UK	1.65	1.45	0.94	1.74	0.26	0.48	-0.15	-1.85
US	-0.17	-0.27	0.77	2.24	-0.22	-0.65	-0.01	-0.11

Table 5: Properties and alphas of portfolios sorted on local total volatility

At the beginning of each month between January 1975 and June 2005, market portfolios are sorted into 3 portfolios on their local total volatility in last period. The returns of these three portfolios are equally-weighted in US dollar. This local total volatility is the standard deviation of the daily country market portfolio return in month *t-1*. The portfolio High (H) has market portfolios with top one-third local total volatility. The portfolio Low (L) has market portfolios with bottom one-third local total volatility. The zero-cost portfolio H-L longs portfolio High and shorts portfolio-Low. Jensen's alpha is multiply by 100 so that it can be interpreted as abnormal excess return in percentage. *MKTX* is the global market excess return. *HML* is the global value factor. *SMB* is the global size factor. The capitalization is the simple average of market capitalization in billion US dollar across country and time. The t-statistics are in parentheses.

Rank	Low (L)	2	High (H)	(H-L)
		Global CAPM		
Alpha	0.12	0.24	0.78	0.66
	(1.00)	(1.84)	(4.59)	(3.46)
MKTX	0.76	0.96	1.09	0.33
	(30.16)	(35.28)	(30.11)	(8.14)
		Global Fama-French Two Factors Model (*MKTX and HML*)		
Alpha	0.10	0.19	0.77	0.67
	(0.85)	(1.44)	(4.45)	(3.44)
MKTX	0.76	0.96	1.09	0.33
	(30.07)	(35.28)	(30.03)	(8.13)
HML	0.03	0.09	0.12	-0.02
	(0.68)	(1.92)	(0.19)	(-0.25)
		Global Fama-French Three Factors Model (*MKTX ,HML and SMB*)		
Alpha	0.06	0.15	0.73	0.67
	(0.52)	(1.17)	(4.25)	(3.41)
MKTX	0.78	0.98	1.12	0.33
	(31.20)	(36.01)	(30.56)	(8.03)
HML	-0.01	0.06	-0.03	-0.02
	(-0.25)	(1.14)	(-0.50)	(-0.29)
SMB	0.16	0.14	0.17	0.01
	(4.56)	(3.76)	(3.34)	(0.19)
Capitalization	649	431	352	

Table 6: Properties and alphas of portfolios sorted on local idiosyncratic volatility

At the beginning of each month between January 1975 and June 2005, market portfolios are sorted into 3 portfolios on their local idiosyncratic volatility in last period. The returns of these three portfolios are equally-weighted in US dollar. $IVol_{i,t-1}$, the local idiosyncratic volatility of market i, is the standard deviation of the idiosyncratic component $\varepsilon_{i,t}$ from the regression:

$$R_{i,\tau} = \alpha + \beta_{i,m,t-1} MKTX_{\tau} + \beta_{i,h,t-1} HML_{\tau} + \beta_{i,s,t-1} SMB_{\tau} + \varepsilon_{i,\tau}, \quad \tau = t-36,..,t-1,$$

where *MKTX* is the global market excess returns, *HML* is the global value factor, and *SMB* is the global size factor. The portfolio High (H) has market portfolios with top one-third local idiosyncratic volatility. The portfolio Low (L) has market portfolios with bottom one-third local idiosyncratic volatility. The zero-cost portfolio H-L longs portfolio High and shorts portfolio-Low. Jensen's alpha is multiply by 100 so that it can be interpreted as abnormal excess return in percentage. The capitalization is the simple average of market portfolio value in billion US dollar across country and time. The t-statistics are in parentheses.

Rank	Low (L)	2	High (H)	(H-L)
		Global CAPM		
Alpha	0.12	0.31	0.66	0.54
	(1.57)	(2.25)	(3.51)	(2.93)
MKTX	0.92	0.96	0.95	0.03
	(54.31)	(32.69)	(23.58)	(0.68)
		Global Fama-French Two Factors Model (*MKTX and HML*)		
Alpha	0.12	0.28	0.62	0.50
	(1.50)	(1.99)	(3.23)	(2.67)
MKTX	0.92	0.95	0.94	0.02
	(54.16)	(32.81)	(23.50)	(0.62)
HML	0.01	0.06	0.08	0.07
	(0.19)	(1.13)	(1.11)	(1.06)
		Global Fama-French Three Factors Model (*MKTX ,HML and SMB*)		
Alpha	0.11	0.25	0.57	0.46
	(1.41)	(1.80)	(3.04)	(2.49)
MKTX	0.92	0.97	0.97	0.05
	(53.36)	(33.41)	(25.04)	(1.24)
HML	-0.00	0.02	0.02	0.02
	(-0.12)	(0.37)	(0.28)	(0.34)
SMB	0.03	0.14	0.21	0.18
	(1.42)	(3.52)	(3.87)	(3.34)
Capitalization	972	273	266	

Table 7: Properties and alphas of portfolios sorted on local idiosyncratic volatility measure-II

At the beginning of each month between January 1975 and June 2005, market portfolios are sorted into 3 portfolios on their local idiosyncratic volatility measure-II in last period. The returns of these three portfolios are equally-weighted in US dollar. $IVol^{II}_{i,t-1}$, the local idiosyncratic volatility measure-II of market *i*, is the standard deviation of the idiosyncratic component $\varepsilon_{i,t}$ from regression:

$$R_{i,\tau} = \alpha + \beta_{i,m,t-1} MKTX_{\tau} + \varepsilon_{i,\tau}, \quad \tau = 0,..,D_{t-1},$$

where *MKTX* is the global market excess returns and D_{t-1} is the number of trading day in month *t-1*. The portfolio High (*H*) has market portfolios with top one-third local idiosyncratic volatility. The portfolio Low (*L*) has market portfolios with bottom one-third local idiosyncratic volatility. The zero-cost portfolio H-L longs portfolio High and shorts portfolio-Low. Jensen's alpha is multiply by 100 so that it can be interpreted as abnormal excess return in percentage. The capitalization is the simple average of market portfolio value in billion of US dollars across country and time. The t-statistics are in parentheses.

Rank	Low (L)	2	High (H)	(H-L)
		Global CAPM		
Alpha	-0.08	0.31	0.87	0.95
	(-0.85)	(2.36)	(4.89)	(5.11)
MKTX	0.95	0.93	0.93	-0.01
	(45.35)	(33.44)	(24.34)	(-0.36)
		Global Fama-French Two Factors Model (*MKTX and HML*)		
Alpha	-0.11	0.30	0.83	0.94
	(-1.09)	(2.26)	(4.55)	(4.91)
MKTX	0.95	0.93	0.93	-0.02
	(45.28)	(33.35)	(24.26)	(-0.38)
HML	0.05	0.01	0.08	0.03
	(1.30)	(0.21)	(1.24)	(0.46)
		Global Fama-French Three Factors Model (*MKTX ,HML and SMB*)		
Alpha	-0.14	0.26	0.78	0.92
	(-1.37)	(2.01)	(4.36)	(4.81)
MKTX	0.96	0.95	0.95	-0.01
	(45.36)	(33.92)	(24.79)	(-0.14)
HML	0.02	-0.03	0.04	0.01
	(0.58)	(-0.61)	(0.52)	(0.19)
SMB	0.11	0.15	0.17	0.07
	(3.67)	(4.05)	(3.35)	(1.26)
Capitalization	512	551	424	

Table 8: Properties and alphas of portfolios sorted on past betas β_i^v of the mimicking factor of global volatility innovation

This table reports the properties and alphas of the equal-weighted portfolios sorted on betas of the mimicking factor **of** global volatility innovation for the period from January 1976 to June 2005. β_i^v , the market *i*'s past beta of the mimicking factor, is from the following regression:

$$R_{i,\tau} = \alpha_{i,t-1} + \beta_{i,t-1}^m MKTL_\tau + \beta_{i,t-1}^h HML_\tau + \beta_{i,t-1}^s SMB_\tau + \beta_{i,t-1}^v MVol_\tau + \varepsilon_{i,\tau} \quad \tau = t-60,..,t-1,$$

where *MKTX, HML* and *SMB* are the global market return, value and size factors. $MVol_t$, the mimicking factor of global volatility innovation, is $\beta'_F\ MF$ from the economic tracking model $\Delta Vol_t = \beta_0 + \beta'_F\ MF_t + \theta\Delta Vol_{t-1} + \varepsilon_t$, where *MF* is the 8x1 vector of eight global economic tracking portfolios. All stocks in the global market are sorted into the top 30% (high), the bottom 30% (low), and medium 40% (medium) based on their market characteristics. These characteristics are book-to-market ratios, earnings-to-price ratios, cash earnings-to-price ratios, the dividend yields, and their past six month returns. The eight global economic tracking portfolios are the value-weighted return on the high book-to-market portfolio, the value-weighted return on the low book-to-market portfolio, the value-weighted return on the high earnings-to-price portfolio, the value-weighted return on the low earnings-to-price portfolio, the value-weighted return on the high cash earnings-to-price portfolio, the value-weighted return on the low cash earnings-to-price portfolio, the value-weighted return on the high dividend yield portfolio, the value-weighted return on the low dividend yield portfolio. The portfolio Low (L) has lowest global market volatility innovation risk beta. The portfolio High (H) has highest global market volatility innovation risk beta. The zero-cost portfolio H-L longs portfolio High and shorts portfolio-Low. The Jensen's alpha is multiply by 100. The market capitalization is in billion US dollars. The t-statistics are in parentheses.

Rank	Low (L)	2	High (H)	(H-L)
		CAPM		
Alpha	0.30	0.22	0.11	-0.40
	(1.53)	(1.18)	(0.55)	(-1.76)
MKT	1.09	1.66	0.95	0.03
	(22.59)	(23.80)	(19.01)	(0.53)
		Fama-French Two Factors (*MKTX and HML*)		
Alpha	0.50	0.09	-0.00	-0.50
	(2.77)	(0.48)	(0.02)	(-2.19)
MKT	0.92	1.07	0.95	0.03
	(21.33)	(24.29)	(19.28)	(0.59)
HML	0.02	0.23	0.22	0.19
	(0.37)	(3.55)	(2.90)	(2.31)
		Fama-French Three Factors (*MKTX ,HML and SMB*)		
Alpha	0.43	-0.01	-0.11	-0.53
	(2.70)	(-0.09)	(-0.65)	(-2.34)
MKT	0.91	1.06	0.94	0.03
	(24.26)	(32.23)	(23.82)	(0.55)
HML	-0.03	0.16	0.14	0.17
	(-0.58)	(3.13)	(2.26)	(2.04)
SMB	0.38	0.53	0.53	0.15
	(10.24)	(16.28)	(13.67)	(2.85)
Capitalization	549	423	286	

Table 9: The pricing premium for the mimicking factor of global volatility innovation

This table reports the pricing premium of the global market excess return (*MKTX*), the global value factor (*HML*), the global size factor (*SMB*) and the global market volatility innovation mimicking factor (*MVol*) using Fama-MacBeth the following regressions for the sample period from January 1976 to June 2005:

$$R_{i,t} = \psi_0 + \psi_m \beta^m_{i,t-1} + \psi_h \beta^h_{i,t-1} + \psi_s \beta^s_{i,t-1} + \psi_v \beta^{MVol}_{i,t-1} + \eta_{i,t} \ , \qquad \text{(A)}$$

where $\beta^m_{i,t-1}$ is the market beta, $\beta^h_{i,t-1}$ is the value beta, $\beta^s_{i,t-1}$ is the size beta, and $\beta^v_{i,t-1}$ is the market volatility innovation mimicking risk beta. These betas are estimated from the following regression:

$$R_{i,\tau} = \alpha_{i,t-1} + \beta^m_{i,t-1} MKTL_\tau + \beta^h_{i,t-1} HML_\tau + \beta^s_{i,t-1} SMB_\tau + \beta^v_{i,t-1} MVol_\tau + \varepsilon_{i,\tau} \quad \tau = t-60,..,t-1, \qquad \text{(B)}$$

where *MKTX, HML* and *SMB* are the global market return, value and size factors. $MVol_t$, the global market volatility innovation risk mimicking factor, is $\beta'_F MF$ from the economic tracking model $\Delta Vol_t = \beta_0 + \beta'_F MF_t + \theta \Delta Vol_{t-1} + \varepsilon_t$, where *MF* is the 8x1 vector of eight economic tracking portfolios. The premiums of *MKTX, HML* and *SMB* factors are multiply by 100; and the premium of mimicking world market volatility innovation risk factor is multiply by 100^2. All stocks in the global market are sorted into the top 30% (high), the bottom 30% (low), and medium 40% (medium) based on their market characteristics. These characteristics are book-to-market ratios, earnings-to-price ratios, cash earnings-to-price ratios, the dividend yields, and their past six month returns. The eight economic tracking portfolios are the value-weighted return on the high book-to-market portfolio, the value-weighted return on the low book-to-market portfolio, the value-weighted return on the high earnings-to-price portfolio, the value-weighted return on the low earnings-to-price portfolio, the value-weighted return on the high cash earnings-to-price portfolio, the value-weighted return on the low cash earnings-to-price portfolio, the value-weighted return on the high dividend yield portfolio, the value-weighted return on the low dividend yield portfolio. The t-statistics are in parentheses.

β^{MKTX}	β^{HML}	β^{SMB}	β^{MVol}
0.37	-0.32	-0.19	
(1.64)	(-1.48)	(-0.59)	
0.47	-0.20	-0.29	-1.37
(1.47)	(-0.20)	(-0.84)	(-1.91)

Table 10: The dominant nature of local total volatility

This table reports the dominant nature of market volatility as a characteristic over other global risk factors by using Fama-MacBeth (1973) regressions:

$$R_{i,t} = \psi_0 + \sum_{j=1}^{M} \psi_\beta \beta^j_{i,t-1} + \psi_{vol} Vol_{i,t-1} + \varepsilon_{i,t} \qquad \text{(a)}$$

where $\beta^j_{i,t-1}$ is the sensitivity of market portfolio return *i* to global factor *j* that is one of the global market (*MKTX)*, value (*HML)*, size (*SMB*), and volatility innovation risk mimicking factors, $Vol_{i,t-1}$, the last period total market volatility of market *i*, is the standard deviation of market portfolio daily return in US dollar in month *t-1*. β^{mktx}, β^{hml}, and β^{smb} in regression I are obtained from the following regression:

$$R_{i,\tau} = \alpha + \beta_{i,m,t-1} MKTX_\tau + \beta_{i,h,t-1} HML_\tau + \beta_{i,s,t-1} SMB_\tau + \varepsilon_{i,\tau}, \quad \tau = t-36,..,t-1 \qquad \text{(b)}$$

β^{mktx}, β^{hml}, β^{smb}, and β^{volm} in regression II are obtained from the following regression:

$$R_{i,t} = \alpha_i + \beta^m_i MKTX + \beta^h_i HML_t + \beta^s_i SMB_{t-1} + \beta^v_i MVol_t + \varepsilon_{i,t} \quad \tau = t-60,..,t-1, \qquad \text{(c)}$$

where $MVol_t$, global market volatility innovation risk mimicking factor, is $\beta'_F\, MF$ from the economic tracking model $\Delta Vol_t = \beta_0 + \beta'_F\, MF_t + \theta \Delta Vol_{t-1} + \varepsilon_t$, where MF is the 8x1 vector of eight economic tracking portfolios. All stocks in the global market are sorted into the top 30% (high), the bottom 30% (low), and medium 40% (medium) based on their market characteristics. These characteristics are book-to-market ratios, earnings-to-price ratios, cash earnings-to-price ratios, the dividend yields, and their past six month returns. The eight economic tracking portfolios are the value-weighted return on the high book-to-market portfolio, the value-weighted return on the low book-to-market portfolio, the value-weighted return on the high earnings-to-price portfolio, the value-weighted return on the low earnings-to-price portfolio, the value-weighted return on the high cash earnings-to-price portfolio, the value-weighted return on the low cash earnings-to-price portfolio, the value-weighted return on the high dividend yield portfolio, the value-weighted return on the low dividend yield portfolio. The coefficient of the global market volatility innovation risk mimicking factor is multiply by 100^2, and the other coefficients are multiply by 100. The sample period is from January 1976 to June 2005. The t-statistics are in parentheses.

	Market portfolio total volatility	
	Regression I	Regression II
Vol_{t-1}	0.88*	1.32*
	(3.18)	(4.12)
β^{mktx}	-0.16	-0.32
	(-0.50)	(-0.98)
β^{hml}	-0.04	-0.49
	(-0.22)	(-1.90)
β^{smb}	-0.12	0.18
	(-0.43)	(0.46)
β^{volm}		-0.03
		(-0.04)

Table 11: The dominant nature of local idiosyncratic volatility

This table reports the dominant nature of market portfolio idiosyncratic volatility as a characteristic over other global risk factors by using Fama-MacBeth (1973) regression (a):

$$R_{i,t} = \psi_0 + \sum_{j=1}^{M} \psi_\beta \beta^j_{i,t-1} + \psi_{vol} IVol_{i,t-1} + \varepsilon_{i,t} \qquad \text{(a)}$$

where $\beta^j_{i,t-1}$ is the sensitivity of market portfolio return *i* to global factor *j* that is one of the global market (*MKTX)*, value (*HML)*, size (*SMB*), and volatility innovation risk mimicking factors. In panel A: $IVol_{i,t-1}$, the local idiosyncratic volatility in the last period, is the standard deviation of idiosyncratic component $\varepsilon_{i,t}$ from the regression (b):

$$R_{i,\tau} = \alpha + \beta_{i,m,t-1} MKTX_\tau + \beta_{i,h,t-1} HML_\tau + \beta_{i,s,t-1} SMB_\tau + \varepsilon_{i,\tau}, \quad \tau = t-36,..,t-1, \qquad \text{(b)}$$

where *MKTX, HML* and *SMB* are the monthly global market return, value and size factors. In panel B, $IVol_{i,t-1}$,the local idiosyncratic volatility of market *i* in the last period, is the standard deviation of idiosyncratic component $\varepsilon_{i,t}$ from the following regression (c) after adjusting for global daily market factor $MKTX_\tau$:

$$R_{i,\tau} = \alpha_i + \beta_{i,t-1} MKTX_\tau + \varepsilon_{i,\tau}, \tau = 1,.., D_{t-1} \qquad \text{(c)}$$

β^{mktx}, β^{hml}, and β^{smb} in regression I and III are obtained from regression (c). β^{mktx}, β^{hml}, β^{smb}, and β^{volm} in regression II and IV are obtained from the following regression (d):

$$R_{i,t} = \alpha_i + \beta^m_i MKTX + \beta^h_i HML_t + \beta^s_i SMB_{t-1} + \beta^v_i MVol_t + \varepsilon_{i,t} \quad \tau = t-60,..,t-1, \qquad \text{(d)}$$

where $MVol_t$, global market volatility innovation risk mimicking factor, is $\beta'_F MF$ from the economic tracking model $\Delta Vol_t = \beta_0 + \beta'_F MF_t + \theta \Delta Vol_{t-1} + \varepsilon_t$, where MF is the 8x1 vector of eight economic tracking portfolios. All stocks in the global market are sorted into the top 30% (high), the bottom 30% (low), and medium 40% (medium) based on their market characteristics. These characteristics are book-to-market ratios, earnings-to-price ratios, cash earnings-to-price ratios, the dividend yields, and their past six month returns. The eight economic tracking portfolios are the value-weighted return on the high book-to-market portfolio, the value-weighted return on the low book-to-market portfolio, the value-weighted return on the high earnings-to-price portfolio, the value-weighted return on the low earnings-to-price portfolio, the value-weighted return on the high cash earnings-to-price portfolio, the value-weighted return on the low cash earnings-to-price portfolio, the value-weighted return on the high dividend yield portfolio, the value-weighted return on the low dividend yield portfolio. The coefficient of the global market volatility innovation risk mimicking factor is multiply by 100^2, and the other coefficients are multiply by 100. The sample period is from January 1976 to June 2005. The t-statistics are in parentheses.

	Panel A		Panel B	
	Local idiosyncratic volatility		Local idiosyncratic volatility measure-II	
	Regression I	Regression II	Regression III	Regression IV
$IVol_{t-1}$	0.17*	0.23*	0.99*	1.22*
	(3.11)	(3.03)	(3.58)	(4.05)
β^{mktx}	0.29	0.50	0.14	0.34
	(0.95)	(1.55)	(0.45)	(1.04)
β^{hml}	-0.08	-0.06	-0.07	-0.11
	(-0.44)	(-0.24)	(-0.40)	(-0.50)
β^{smb}	-0.53	-0.34	-0.38	-0.18
	(-1.85)	(-0.98)	(-1.37)	(-0.50)
β^{volm}		-0.33		-0.57
		(-0.41)		(-0.74)

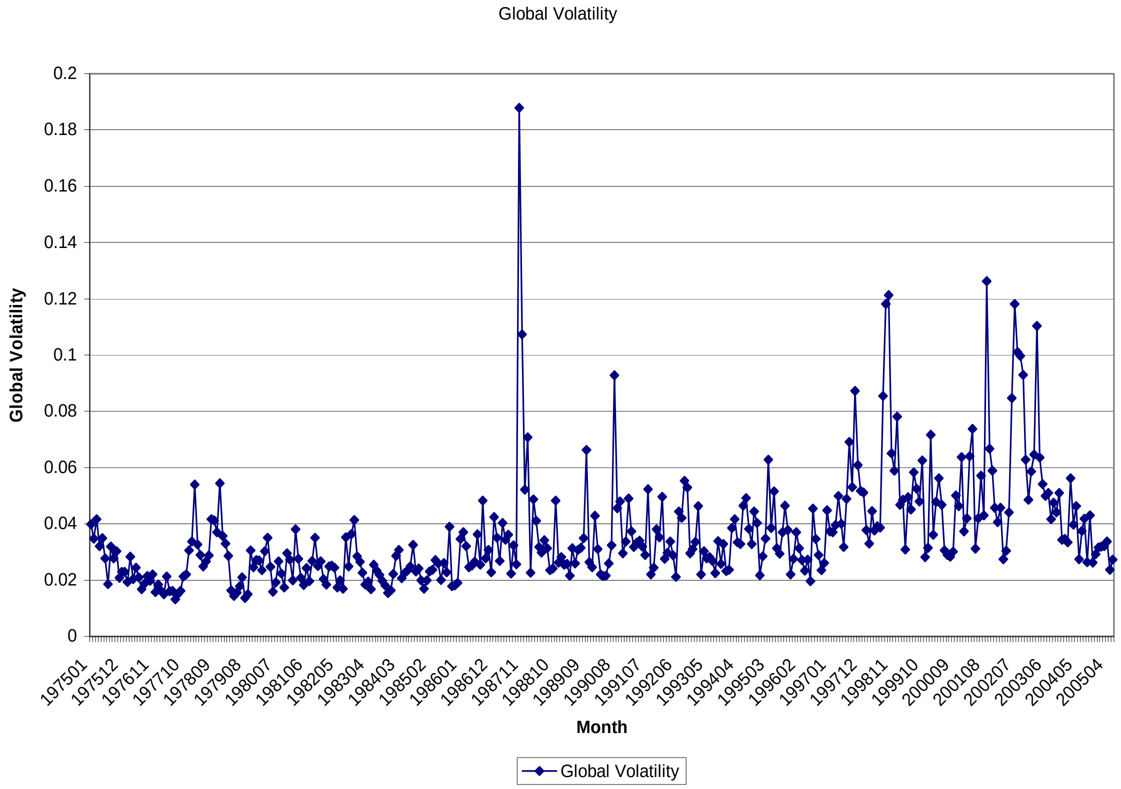

Figure 1: The global volatility plot. The global volatility is the standard deviation of daily value-weighted global market return times $\sqrt{250/12}$. The X-axial is the time in month unit and the Y-axial is the monthly volatility.