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A model-independent measure of aggregate idiosyncratic risk ☆

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ABSTRACT

This paper introduces a model-independent measure of aggregate idiosyncratic risk, which does not require estimation of market betas or correlations and is based on the concept of gain from portfolio diversification. The statistical results and graphical analyses provide strong evidence that there are significant level and trend differences between the average idiosyncratic volatility measures of Campbell et al. [Campbell, J.Y., Lettau, M., Malkiel, B.G., and Xu, Y., 2001, Have individual stocks become more volatile? An empirical exploration of idiosyncratic risk, Journal of Finance 56, 1–43.] and the new methodology. Although both approaches indicate a noticeable increase in the firm-level idiosyncratic risk, the volatility measure of CLMX is greater and has a stronger upward trend than the new idiosyncratic volatility measure. For both measures of idiosyncratic risk, the upward trend is found to be stronger for smaller, lower-priced, and younger firms. The analytical and empirical results show that the significant upward trend in the differences of the two idiosyncratic volatility measures is related to the increase in the cross-sectional dispersion of the volatility of individual stocks.

1. Introduction

Campbell, Lettau, Malkiel and Xu (2001) (hereafter CLMX) decompose the return of an individual stock into three components to study the volatility of stock returns at the market, industry, and firm levels. CLMX use the firm-level return data to examine the volatility of the value-weighted NYSE/AMEX/Nasdaq composite index and the value-weighted average idiosyncratic volatility. Their results provide strong evidence for a positive deterministic trend in the firm-level idiosyncratic volatility for the period of July 1962 to December 1997.

Schwert (1989) finds that the market volatility has no significant trend over the sample period of 1859–1987. Although there has been a strong belief that stock market volatility has increased over time CLMX confirm and update Schwert's finding that aggregate stock market volatility does not exhibit any visible upward slope from July 1962 to December 1997. CLMX conclude that

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the stock market has become more volatile over the sample period of 1962–1997 but on a firm level instead of a market or industry level. The trend increase in idiosyncratic volatility relative to market volatility implies that the correlations among individual stock returns and the explanatory power of the market model for a typical stock have declined. It is also more difficult to diversify away idiosyncratic risk with a limited number of stocks in a portfolio.

Xu and Malkiel (2003) decompose the total volatility of individual stocks into systematic volatility and idiosyncratic volatility and provide strong evidence that the average idiosyncratic volatility has trended upwards. They find that the increase in idiosyncratic volatility is associated with the increasing share of trading in the Nasdaq market, the degree of institutional ownership in the stock market, and the expected earnings growth of individual stocks. Irvine and Pontiff (2005) show that the upward trend in aggregate idiosyncratic risk is related to an increase in the idiosyncratic volatility of fundamental cash flows. They also argue that the rise in cash flow volatility can be explained by increasing competition in various industries.

Brandt, Brav, and Graham (2005) and Bekaert, Hodrick, and Zhang (2005) cast doubts on the existence of significant upward trend in aggregate idiosyncratic volatility. They find that the positive trend is specific to the 1962–1997 sample period, and the episode of very high idiosyncratic volatility in the 1990s is limited to stocks with low institutional ownership and low stock price. Cao, Simin, and Zhao (in press) indicate that controlling for growth options eliminates or even reverses the upward trend in firm-level volatility. Brown and Kapadia (2007) show that the trend in idiosyncratic volatility is driven by new listings. Wei and Zhang (2006) provide evidence that the upward trend in idiosyncratic volatility is explained by a drop in return-on-equity and an increase in the volatility of the return-on-equity, especially in new listings. These articles indicate that firm size, price, and age are important characteristics to explain the upward trend in idiosyncratic volatility.

The aforementioned studies compute the average idiosyncratic volatility based on the variance decomposition or using the residuals from the one-factor capital asset pricing model (CAPM) or three-factor model of Fama and French (1993). The excess return of an individual stock is defined in previous studies as the sum of its systematic excess return component and its idiosyncratic return component. Then, the idiosyncratic risk is measured by the variance decomposition or by factor models assuming a certain parametric specification for the return generating process. In other words, the estimation of aggregate idiosyncratic risk has so far been model-dependent.

Earlier studies including Campbell et al. (2001) and Xu and Malkiel (2003) define total risk of an individual stock i as $\sigma_i^2 = f(M) + g(\varepsilon_i)$, where $f(M)$ is the portion of total variance explained some model M. If the model is correct and we are fully diversified then $g(\varepsilon_i)$ is irrelevant as in the CAPM. However, measuring the idiosyncratic risk by $g(\varepsilon_i)$ is meaningful only if the model M is correct. If we have various models M_1, M_2, M_3,... we end up with different measures of idiosyncratic risk for the same individual stock i. Unless we know the correct model we cannot obtain an accurate and unique measure of idiosyncratic volatility. For example, if we need to calculate the number of stocks that should be held to achieve a certain level of diversification, model-dependent measures of idiosyncratic volatility will generate different numbers.

Two basic related properties implied by the CAPM are that all investors hold in their portfolio all the risky securities available in the market, and that investors hold the risky assets in the same proportions, as these assets are available in the market, independent of the investors' preference. However, these properties contradict with the market experience. First, investors differ in their investment strategy and do not necessarily adhere to the same risky portfolio. Second, the typical investor usually does not hold many risky assets in his portfolio for various reasons, such as transaction costs, incomplete information, indivisibility of investment, institutional restrictions, liquidity constraints, or any other exogenous reasons. Therefore, when calculating the number of stocks that should be held to achieve a given level of diversification it is inappropriate to use the CAPM common decomposition of the variance as it is assumed that one holds small number of stocks. In other words, using the factor or CAPM based models in estimating idiosyncratic volatility may lead to inaccurate or inconsistent measures of diversifiable risk.

If investors held all the risky securities available in the market, the expected return of individual stocks would be determined solely by their contribution to the risk of the market portfolio (i.e., only systematic risk would affect expected returns). However, Blume and Friend (1975) find that the average number of securities held in a portfolio of typical investor is about 3.41. Barber and Odean (2000) report that the mean household's portfolio contains only 4.3 stocks and the median household invests in 2.61 stocks. Both studies indicate that most individuals hold very small number of stocks in their portfolios. With a constraint on the number of securities in the portfolio idiosyncratic risk becomes an important component of the investor's asset allocation decision as it affects the expected return and risk of the portfolio.

Furthermore, there are several asset pricing models in the literature that take idiosyncratic risk into account. For example, Levy (1978) shows in a framework with limited diversification that the equilibrium asset pricing equation relates the returns of individual stocks to their beta with the market and their beta with respect to a market-wide measure of idiosyncratic risk. Hence, measuring and investigating the aggregate idiosyncratic risk have important implications for asset pricing models where the investors hold undiversified portfolios.

This paper introduces a model-independent measure of aggregate idiosyncratic risk based on the mean-variance portfolio theory and the concept of gain from portfolio diversification. With the new approach, there is no need to estimate the covariance terms or the industry-level or firm-level beta coefficients when constructing the average idiosyncratic risk at the industry- or firm-level.

Since there is no gain from diversification when the correlations among individual stocks equal one, the variance of the portfolio with perfectly correlated securities contains systematic risk and idiosyncratic risk of the securities in the portfolio.[3] We also think that the stock market index can be viewed as a fully diversified portfolio, which does not contain any idiosyncratic risk.

[3] In this paper, the portfolio with perfectly correlated securities is called the “non-diversified” portfolio.