The determinants of idiosyncratic volatility

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January 27, 2004

*We would like to thank for helpful discussions, comments, and insights Greg Brown, Jennifer Conrad, Eitan Goldman, Adam Reed and Jörg Rocholl. Address e-mail correspondence to Patrick Dennis at pjd9v@virginia.edu or Deon Strickland at deon_strickland@unc.edu.

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Abstract

This paper investigates the time-series and cross-sectional determinants of idiosyncratic volatility. In the time-series, we find that firm-level volatility is positively related to increased institutional ownership, increased firm focus, and leverage. Furthermore, the explanatory power of market-model regressions has decreased over our sample period, and is negatively related to institutional ownership, increased firm focus, and leverage. In the cross-section, changes in idiosyncratic volatility are positively related to changes in institutional ownership. In addition, we find evidence of a positive relation between changes in ownership of equities by mutual funds and changes in idiosyncratic volatility after controlling for changes in institutional ownership. Last, when we condition on return, we find that there is a decrease in idiosyncratic volatility following both positive and negative returns. This finding is inconsistent with the leverage hypothesis. The decrease in idiosyncratic volatility is consistent, however, with a reduction in asymmetric information following the release of firm specific news.

1 Introduction

The nature of the volatility of equity returns is central to portfolio theory, option valuation, and asset pricing models. Early seminal works in finance, such that of Markowitz (1952), Sharpe (1964), Lintner (1965), Mossin (1966), Black and Scholes (1973) assume that the volatility of equity returns is known and constant. We know, however, that this is not the case. Volatility is stochastic, and appears to be negatively correlated with equity returns: Volatility is higher after negative returns and lower after positive returns (Wu (2001), Bekart and Wu (2000)). This volatility asymmetry is particularly important for option pricing, and models such as Heston (1993) have been developed to accommodate this phenomenon. However, we still do not have a clear understanding of the driver of this volatility asymmetry.

In addition to volatility asymmetry, volatility does not appear to be constant through time. Though the volatility of the overall market has been relatively constant for the past 30 to 40 years, the idiosyncratic volatility of individual equity returns has increased over the same time period (Campbell, Lettau, Malkiel, and Xu (2001), hereafter CMLX). This has important implications for asset pricing, particularly since there is recent evidence that investors appear to be under-diversified (Huberman (2001), Kumar and Goetzmann (2002)). Goyal and Santa-Clara (2003) find evidence of a positive relation between idiosyncratic volatility and the market return. While their finding is inconsistent with systematic risk models, Barberis and Huang (2001) provide a prospect theory based asset pricing in which investors price idiosyncratic volatility.

In this paper we investigate various explanations for both the increase in idiosyncratic volatility over the past several decades and the asymmetric volatility effect. The increase in the idiosyncratic volatility over time could result from several factors. First, as Black (1976), Christie (1982) and others have pointed out, an increase in leverage could amplify the volatility of equity returns. Second, CMLX (2001) hypothesize that institutional ownership may be related to this phenomena. We know that the institutional ownership of stocks has increased over the past several decades, and that institutions tend to trade much more than retail investors (Gompers and Metrick (2001)). Furthermore, there are many reasons why institutions may herd together and trade in the same direction, such as labor market considerations (Scharfstein and Stein (1990)), cascade effects from sequential decision making (Bannerjee (1992)), short horizons (Froot, Scharfstin and Stein (1992)), and destabilizing rational speculation (DeLong, Shleifer, Summers and Waldmann (1990)). We also know that the short-term demand curve for stocks is not perfectly elastic, hence aggregate institutional trades in the same direction will tend to move prices and increase volatility (Chan and Lakonishok (1995)). A third reason for the increase in idiosyncratic volatility could be changes in firm focus. Since a firm's stock price reflects the value of the portfolio of the different business segments, as firm focus increases and the number of business segments decreases, the volatility of the stock price may increase.

Similar to Gompers and Metrick (2001), we find that institutional ownership has increased almost monotonically over the past 20 years, from a value of 19% in 1984 to a value of 34%fs in 2002. Furthermore, we find that firm focus based on the number of business segments, the revenue-based Herfindahl index and the asset-based Herfindahl index has increased over the past 20 years. Using firm fixed-effects regressions, we find that both institutional ownership and firm focus are strongly related to the increase in both total and idiosyncratic firm volatility during our sample period. We also find a positive relationship between leverage and total and idiosyncratic volatility, but since leverage has not increased over the past 20 years, leverage cannot be responsible for the increase in idiosyncratic volatility.

The second question that we address in the paper is what drives the asymmetric volatility effect. One explanation is leverage: Assuming constant volatility for the market value of a firm's assets, a positive return shock decreases the leverage of the firm resulting in decreased equity volatility. Another explanation in based on the herding behavior of managers. Managers have an incentive to mimic the actions of other managers to increase their chances of being viewed as 'smart' by the labor market (Scharfstein and Stein (1990)). Due to the manager's risk aversion, they are more likely to be concerned about their labor market prospects when the market is down following negative returns than when the market is up following positive returns. Hence their incentive to mimic the actions of other managers should be stronger following negative returns that following positive returns. The increase in herding following negative returns increases the volatility for stocks that are dominated by institutions. Consistent with the theory, we find evidence that firms with positive (negative) changes in institutional ownership have higher (lower) idiosyncratic volatility in the next period.

Section 2 provides details our hypothesis of why firm focus, leverage, and institutional are determinants of idiosyncratic volatility. Section 3 describes the construction of the data set and defines the variables we employ in our regression analysis. Sections 4 contains the time-series analysis. Section 5 contains the cross-sectional analysis and section 6 concludes the paper.

2 Hypotheses

We examine three reasons for changes in a firm's idiosyncratic volatility in the time-series and cross-section: ownership structure, firm focus, and leverage. In this section we describe why each of these should affect firm volatility.

2.1 Institutional Ownership

The hypothesis that institutional ownership could affect firm volatility is based on three stylized facts: institutions tend to herd together, institutions trade frequently compared to retail investors, and institutional trades move prices. There are several models in the literature that provide motives for the herding behavior of institutional managers. In all of these models, the herding results in an inefficient equilibrium, where the private information that the managers have is not fully impounded in the observable market prices. First, managers may rationally choose to focus only on information that pays off in the short term and to ignore valuable information that may take a long time to be impounded into the price (Froot, Scharfstein, and

Stein (1992)). Second, managers are concerned about their reputations in the labor market. A manager's reputation is hurt less if everyone makes the same poor investment decision. A risk-averse manager will run with the herd instead of going out on a limb and following a contrarian strategy, even if the manager has information that the contrarian strategy has the higher probability of being correct (Scharfstein and Stein (1990)). Third, if the information that managers have is revealed sequentially, herding could occur (Banerjee (1992)), or managers may choose to ignore their own private information and follow the actions of those before them, resulting in a cascade effect (Bikhchandani and Welch (1992)). Finally, if there are positive feedback traders in the market then rational speculation can cause asset prices to deviate from their fundamental values (De Long, Shleifer, Summers, and Waldmann (1990)). A rational agent will purchase more stock than he would if the positive feedback traders were not present, knowing that the positive feedback traders will buy when the price starts to rise. As the positive feedback traders purchase more of the firm's stock, the price rises even further, enabling the rational speculator to capture additional profits. This type of rational destabilizing speculation can create speculative bubbles, drive prices away from their fundamental values, and contribute to market volatility.

Many empirical studies on institutional herding, such as Klemkosky (1977), Kraus and Stoll (1972), Lakonishok, Shleifer, and Vishny (1992), and Wermers (1999), have not found a large degree of herding on the part of institutions. One reason that this may be the case is that most of these studies use quarterly institutional holdings of stocks (monthly in the case of Kraus and Stoll (1972)) to compute changes in institutional holdings, and this may not be temporally precise enough to detect herding.

A series of recent studies, however, overcome the limitation of using quarterly holdings data to test for herding, either using proprietary data sets or different methodologies. Dennis and Strickland (2002) condition on an event of a positive or negative market return greater than 2% in magnitude, and find that stocks with higher institutional ownership have a greater absolute value of return than stocks with lower institutional ownership, which is consistent with herding on the part of institutions. Griffin, Harris and Topaloglu (2003) use 10 months of proprietary data that indicates whether trades are coming from individuals or institutions, and they find a strong contemporaneous correlation between changes in institutional ownership and stock returns on a daily level.

By itself, herding is insufficient to cause volatility. There must be a sufficient amount of trading and these trades must move prices. Gompers and Metrick (2001) show that institutional ownership of stocks has nearly doubled from 1980 to 1995, and, more importantly, the increase in trading activity among institutions has increased even more than institutional ownership over their sample period. Given that institutions frequently, several authors have investigated whether this trading moves prices. Cai and Zheng (2003) find that market returns Granger cause institutional trading, but that institutional trading does not Granger cause returns. This evidence is consistent with positive feedback trading and herding, but inconsistent with the hypothesis that trading by institutions puts pressure on prices. In contrast, Chan and Lakonishok (1995) study the daily transactions from 37 institutions over a 18 month period and find that institutions split large trades into smaller ones and that these trades do move prices. Sias, Starks, and Titman (2001) distinguish between the hypothesis that institutions buy stocks and then their prices increase (price pressure/informed institutions) and the hypothesis that a stock's price increases and then institutions buy it (positive feedback trading). They reject the positive feedback trading hypothesis in favor of the hypothesis that institutions trade because they possess superior information, and these trades move prices. Chakravarty (2001) finds that medium sized trades, defined as 500 to 9,999 shares, move prices more than small trades, defined as 100 to 499 shares, or large trades, defined as 10,000 or more shares. Furthermore, he uses the TORQ data to demonstrate that most of the price movement comes from institutions breaking large trades into a series of medium sized trades.

Our hypothesis that institutional ownership is positively related to volatility is based on the preponderance of evidence that institutions herd, and that their trades move prices. We do not consider whether this is stabilizing in the sense that it moves prices to their fundamental level based on information, or whether it is destabilizing in the sense that is drives prices away from their fundamental level: both can be consistent with an increase in volatility.

2.2 Firm Focus

The equity stake in a multi-segment firm can be viewed as an call option on a portfolio of different business segments (Black & Scholes (1973)). If the correlation between the return to each segment is less than 1.0 and a firm becomes more focused by divesting one or more segments, standard portfolio theory predicts that the idiosyncratic volatility of equity returns will increase.

Figure 1 shows the change in standard deviation that results when a firm focuses in fewer segments. The top line shows the percentage increase in the standard deviation of returns for an all-equity firm when a firm that has three segments divests one, resulting in a firm with two segments. All segments are weighted equally, and each segment by itself has a standard deviation of returns of 20% per year. The change in the volatility of equity returns is shown as a function of the correlation between the business segments. For example, if all segments of a three-segment firm have a correlation of 0.5, then divesting one of these segments results in an increase in equity volatility of 6% per year, from a standard deviation of 16.3% to 17.3% per year. When the correlation is lowest (left of the graph), there is the greatest reduction in volatility from diversifying into more segments, or, alternatively, the greatest increase in volatility from divesting and focusing in fewer segments. Of course, as the correlation between segments approaches one, the increase in volatility from focusing in fewer segments approaches zero.

When the this effect is examined in the context of the entire stock market, it does not necessarily have to be the case that each firm has to divest segments and increase focus to get an increase in the volatility of the average stock in the market. If old firms remain relatively diversified but new firms are created that have a focus in only one or two segments, the volatility of the average firm in the market will increase due to the creation of new, more focused firms.

2.3 Leverage

The effect of leverage on volatility is well understood. If the debt component of a levered firm consists of a single T year zero-coupon bond, then the equity stake can be modeled as a T year call option on the assets of the firm (Black & Scholes (1973)). The same principle applies to firms that issue more than one bond and have bonds that pay coupons. Since the equity position is a levered position on the firm's assets, the volatility of the firm's equity returns is greater than the volatility of the asset's returns by a leverage multiple. Borrowing from Figlewski and Wang (2000), if V is the value of the firm, S is the market value of outstanding equity and D is the value of the debt, them $V = S + D$. Furthermore if the debt is risk-free, then a change in the value of the firm's assets, ΔV is passed entirely through to the equity: $\Delta S = \Delta V$. So the change to the value of a firm's stock caused by a given ΔV is:

$$\frac{\Delta S}{S} = \frac{\Delta V}{S} = \frac{\Delta V}{V}\frac{V}{S} = \frac{\Delta V}{V}\frac{S+D}{S} = \frac{\Delta V}{V}\left(1 + \frac{D}{S}\right) = \frac{\Delta V}{V}L, \tag{1}$$

where L is one plus the debt-to-equity ratio. Taking the standard deviation of both sides, we have $\sigma_S = \sigma_V L$, where σ_V is the volatility of equity returns and σ_S is the volatility of asset returns. In addition to affecting the level of equity volatility, leverage can induce changes in the level of volatility following positive and negative equity return shocks. A positive return shock has the effect of decreasing L and hence decreasing the volatility of equity returns, while a negative return shock has the opposite effect on σ_S.

3 Sample construction and variables

Our research goal is to determine if firm focus, institutional ownership and leverage are important determinants of idiosyncratic volatility. As a result, the analysis must be conducted at the firm level. This contrast sharply with the CLMX (2001) methodology where market, industry, and firm volatility are portfolio means. As a result, our sample consists of the universe of stocks in the CRSP-Compustat merged database for the period 1984-1997. From the CRSP-Compustat database, we extract firm level price, volume, and segment data. To be included in the sample, a firm must exist on the CRSP-Compustat database for 12 contiguous quarters.

3.1 Idiosyncratic volatility

Idiosyncratic volatility is not directly observable. Hence, it is necessary to construct an empirical proxy for idiosyncratic volatility. Our empirical implementation is similar to Malkiel and Xu (2002). We define idiosyncratic volatility as the sum of squared errors from the following regression model:

$$r_t = \alpha + \beta m_t + \epsilon, \tag{2}$$

where r_t is the return for firm i on day t and m_t is the CRSP value-weighted return for day t. We estimate the model for each firm for every quarter during the 1984-1997 period. We also require that r_t exist for all trading days during the quarter. The minimum numbers of trading days in any quarter is 52 and the maximum number of trading days is 64. Table I contains summary statistics for idiosyncratic volatility. The panel mean (median) is 0.1340 (0.0445). CLMX (2001) note that the upward trend in idiosyncratic volatility occurs while the explanatory power of market model regressions is declining. To examine this effect, we also compute the R^2 for each firm for every quarter. Summary statistics for R^2 are presented in Table I. The panel mean (median) for R^2 is 6.47 (2.92) percent.

3.2 Herfindahl, institutional ownership, and leverage

In the previous section, we describe why it is possible that idiosyncratic volatility is related to the time-series evolution of firm focus. Our measure of firm focus is the Herfindahl index. The Herfindahl variable is constructed from the Compustat segment data. Compustat reports the number of business segments, revenue for each segment, and the book value of assets for each segment. We construct revenue and asset firm-level Herfindahl indicies. The construction process is as follows: we divide the reported revenue for each segment by total revenue. Each segment revenue to total revenue ratio is then squared. The squared ratios are summed to produce the revenue Herfindahl index for firm i in year t. The asset Herfindahl index is constructed in the same manner. Table I presents summary statistics for the revenue Herfindahl. The median value for the revenue Herfindahl is one. A value of one indicates that over 50 percent of the firms in our sample report only one segment. There is, however, considerable cross-sectional variation as the mean of the revenue Herfindahl index is less than one and the standard deviation of the revenue Herfindahl is 0.22.

If there is sufficient return data to estimate idiosyncratic volatility, we obtain the percentage institutional ownership. The institutional ownership date for this study are from 13(f) filings. The Securities Act Amendment of 1975 requires that institutional investors report their portfolio holdings to the Securities and Exchange Commission(SEC) on a quarterly basis. The amendment specifies that all institutional investors with investment discretion over portfolios exceeding $100 million in equity securities report the content of their holdings to the SEC. We obtain these data from the CDA/Spectrum database, which records the identity of the institutional investor, most recent trade, and the number of shares held by each institution for a publicly traded securities. Table I presents summary statistics for institutional ownership. The panel mean (median) level of institutional ownership is 24.52 (17.87) percent. This level of institutional ownership is consistent with Gompers and Metrick (2001).

The CDA/Spectrum database also allows us to decompose the institutional ownership structure into four types of institutions: (1) mutual funds and investment advisors, (2) pension funds and endowments, (3) insurance companies, and (4) banks. Data on the total number of outstanding shares are also obtained from CDA/Spectrum. The ability to decompose the institutional ownership into its components it important as there is considerable heterogeneity in the investment goals and horizons of the various types of institutions. Hotchkiss and Strickland (2003) find that mutual funds have greater levels of portfolio turnover relative to other types of institutional investors. This is important as our institutional ownership hypothesis assumes that institutional investor herding is a determinant of idiosyncratic volatility. It is difficult, however, to measure the incremental effect of institutional ownership composition. Mutual fund and total institutional ownership are highly correlated. If both variables are included in our regression analysis, we measure combined rather than independent effects. To address this issue, we calculate the ratio of mutual fund ownership to total institutional ownership. This ratio captures the effect of mutual fund ownership and is not highly correlated with total institutional ownership. Table I presents summary statistics for the mutual fund concentration variable. The panel mean (median) is 60.93 (66.10) percent.

Leverage is defined as the book value of total debt divided by the book value of total assets. The data for leverage are from Compustat. Table I contains summary statistics for leverage. The panel mean (median) of leverage is 53.63 (53.77) percent.

3.3 Control variables

Our set of control variables consists of size and turnover. Size is defined the market value of equity measured on the last day of the calendar quarter. We include size for several reasons. First, size is correlated with institutional ownership. Falkenstein (1996) finds that institutional investors display a revealed preference for larger firms. Second, size is correlated with the degree of firm focus. As firms grow larger, it is more difficult for the firm to operate within a narrow band of industries. Third, Cheung and Ng (1992) find that size is correlated with total volatility. Finally, size is also positively correlated with leverage, as larger firms may find it easier to access the public debt markets. Turnover is defined as the quarterly mean of daily turnover where daily turnover is daily volume of trade divided by the number of shares outstanding. We include turnover to control for the liquidity of the stock. Schwert (1989) finds a positive relationship between aggregate total volatility and trade volume. In addition, Falkenstein (1996) finds that institutional investors prefer more liquid stocks. This is not surprising as institutional investors manage large portfolios and greater liquidity enhances their ability to trade while minimizing the price impact of large trades. Basically, size and turnover are included to ensure that the leverage, the Herfindahl index, and the institutional ownership results are not simply a size or liquidity proxy effect.

Summary statistics for these variables are presented in Table I. The panel mean for size is $626 million while the panel median is only $62 million. This indicates that size is left skewed. To address this issue, we employ the natural logarithm of size in our regression analysis. The panel mean (median)for turnover is 0.33 (0.19) percent. Our sample contains firms from the National Association of Security Dealers (NASD) and trading volume for NASD firms is overstated relative to New York Stock Exchange (NYSE)firms. To control for this issue, the reported daily volume for firms which trade on the NASD are halved (Atkins and Dyl (1997)).

4 Time-series Analysis

While market volatility has remained fairly stable over the past 20 years, CMLX (2001) document an increase in idiosyncratic volatility over the same period. As outlined earlier, this is important since there is recent research that demonstrates that idiosyncratic risk is priced. In this section we test our hypotheses that institutional ownership, firm focus and leverage are related to the increase in firm-level volatility during the sample period.

Table II contains the yearly cross-sectional means of turnover, leverage, revenue-based Herfindahl index, institutional ownership, mutual fund concentration, idiosyncratic volatility, and market model R^2 from 1987 to 1994. While leverage shows no obvious trend either upward or downward over the period, the Herfindahl index increases from a low of 0.82 in 1984 to 0.89 in 1997, and average daily turnover has increased from 0.0020 to 0.0049 over the same period. Similarly, institutional ownership increased from 19% in 1984 to 30% in 1997. Not only has the total institutional ownership increased over this period, but fraction of this total accounted for by mutual funds has also increased, from a low of 51% in 1984 to a high of 73% in 1997.

This is important since mutual funds, as opposed to banks, insurance companies and pension funds, may be more subject to the types of herding behavior outlined earlier due to labor market concerns.

Our measure of idiosyncratic volatility, the sum of squared errors from the market-model regression each quarter, has generally gone up over the time period, while the average R^2 from the market model regression has decreased, consistent with CMLX (2001). The trends in volatility and R^2 are illustrated further in Table III. The first column contains coefficient estimates from regressing the average idiosyncratic volatility for all stocks in each quarter from 3Q1962 to 4Q1997 on a trend variable. The trend variable takes on a value of 1 in 3Q1962 and increases by 1 for each quarter thereafter. The trend variable is significant at the 1% level, providing statistical evidence for the increase in idiosyncratic volatility over the time period. In the second column, the independent variable is a time dummy that is set to 0 before 1980 and 1 afterward. The coefficient is significant at the 1% level, indicating a statistically different mean level of idiosyncratic volatility before and after 1980. The last two columns in the table are the same as the first, except that the independent variable is the average R^2 from all market-model regressions each quarter. The coefficients indicate a statistically significant decline in the explanatory power of the market model over our sample period.

4.1 Regression Methodology

To test our hypotheses concerning the explanatory power of leverage, institutional ownership and firm focus on the increase in volatility of firm-level returns, we use the following fixed effects model:

$$y_{it} = \gamma_i + \gamma_1 size_{it} + \gamma_2 turnover_{it} + \gamma_3 leverage_{it} + \gamma_4 herfindahl_{it} + \gamma_5 io_{it} + \gamma_6 iom_{it} + \xi_{it}, \quad (3)$$

Where i indexes the firm, t indexes the quarter and y is either the firm's idiosyncratic volatility or the R^2 from the market model regression. The firm-fixed effects framework is a robust estimation methodology in the sense that omitted variables which are constant throughout the sample period for a given firm, or omitted variables that may change for a firm through time but are constant for all firms in any given quarter (such as market-wide variables like investor sentiment) are absorbed as a fixed effect and will not bias the results. We include *size* and *turnover* as controls to ensure that institutional ownership is not acting as a proxy for these variables. We know that both of these variables have increased over our sample period, and that institutions prefer liquid stocks and stocks with relatively large market capitalizations (Lakonishok, Shleifer and Vishny (1992), Gompers and Metrick (2001)). The variables *leverage*, *herfindahl* and *io* (institutional ownership) are included for the reasons stated in Section 2. *iom* is a mutual fund concentration variable, which is defined as the fraction of institutional ownership and any point in time that is accounted for by mutual funds.

The fixed-effects model allows us to focus on the pooled time-series effects since firm fixed-effects are absorbed by the intercept term, γ_i. This model is equivalent to one in which there is only one intercept for all firms, but where the dependent variable and each independent variable is de-meaned by subtracting the respective within-firm time-series average of each variable:

$$\begin{aligned} y_{it} - \overline{y_i} = \gamma_0 &+ \gamma_1(size_{it} - \overline{size_i}) + \gamma_2(turnover_{it} - \overline{turnover_i}) + \gamma_3(leverage_{it} - \overline{leverage_i}) \\ &+ \gamma_4(herfindahl_{it} - \overline{herfindahl_i}) + \gamma_5(io_{it} - \overline{io_i}) + \gamma_6(iom_{it} - \overline{iom_i}) + \xi_{it}. \end{aligned} \tag{4}$$

This removes cross-sectional variation of the average value of each variable and allows us to focus on the time-series.

4.2 Results

The results from the estimation are shown in Table IV. The model in the first column includes all independent variables with the exception of mutual fund concentration. The coefficients on the control variable *size* is what we would expect: through time, as a firm gets larger and more mature, its idiosyncratic volatility decreases. Furthermore, as turnover in the firm's shares increases its idiosyncratic volatility increases: it takes trading volume to move prices and create volatility.

The three variables that relate directly to our hypotheses are *leverage*, *herfindahl*, and *io*. We find that higher leverage is associated with higher idiosyncratic volatility. An idiosyncratic shock to the value of the firm's assets is increased by a factor of L and passed through to the equity returns: $\sigma_S = L\sigma_V$. Consistent with modeling a firm as a portfolio of business segments, the positive and statistically significant coefficient on *herfindahl* indicates that an increase in a firm's focus, as measured by the revenue-based Herfindahl index, is associated with an increase in the volatility of the firm's returns. Last, institutional ownership is positive and statistically significant. This is consistent with the herding-based hypotheses outlined is Section 2.

The model in the second column of Table IV is identical to the first column, except that the mutual fund concentration variable is also included. To avoid collinearity problems with the level variable *io*, *iom* is defined as the ratio of mutual fund ownership in a given stock to total institutional ownership in that stock. Again, we feel that it is important to isolate the behavior of mutual funds from other institutions since they represent almost 73% of all institutional ownership as of 1997, and, more importantly, they are the most likely to be subject to labor-market and myopic based herding behavior. Consistent with this, we find that the fraction of institutions that are mutual funds is important in explaining the increase in a firm's idiosyncratic volatility through time, even after accounting for the level of total institutional ownership.

The last two columns of Table IV are identical to the first two, except the dependent variable is now the R^2 from the regression that is used to estimate ϵ. The control variables *size* and *turnover* are associated with a larger R^2 through time. Again, the variables of interest that relate to our hypotheses are *leverage*, *herfindahl* and *io*. We find that increased leverage results in lower market-model explanatory power. As idiosyncratic return shocks occur to the market value of firm's assets, the component that is not orthogonal to the market is multiplied by a factor of L and passes through to the firm's equity return, decreasing the power of the market to explain the firm's returns. Increased firm focus is also results in lower market-model explanatory power. As a firm's business operations become more focused, the asset base of the firm becomes less diversified resulting in a higher proportion of the firm's total volatility being idiosyncratic. Last, as institutional ownership increases in a firm thorough through time, the market-model R^2 decreases, which is consistent with herding behavior on the part of institutions (Dennis and Strickland (2002)). The fourth column of Table IV is identical to the third, except that we have included the mutual fund concentration variable. Consistent with our hypothesis that mutual funds may be more subject to herding than other institutions, we find that an increase in the proportion of mutual fund ownership to total institutional ownership results in lower explanatory power of the market model.

4.3 Robustness Tests

We perform several robustness tests on the models specified in Table IV to verify that our results are not statistical artifacts. First we estimate a balanced regression where we require that all firms be in our sample from 1984 to 1997. We find no change in sign or significance of the independent variable. This ensures that our results are not driven entirely by new firms or that the effects that we find are due to the internet bubble in the mid to late 1990's. Second, volatility can be persistent which could result in serially correlated errors, reducing our standard errors and biasing the t-statistics upward. To control for this we estimate a feasible GLS specification and find that the statistical significance of our results is unchanged. Third, there appears to be some degree of skewness in sum-of-squared errors from the market model regression, so we re-estimate the models in Table IV with $log(\epsilon)$ as the dependent variable instead of ϵ, and find that our results do not change. Last, we replicate all the specifications in Table IV using two measures of firm focus in place of the revenue-based Herfindahl index. As in Comment and Jarrell (1995), we create an asset-based Herfindahl index and a measure of firm focus which is simply the number of business segments that the firm operates in. We find our results are robust to these additional proxies for firm focus - as firms become more focused through time idiosyncratic volatility increases and the R^2 of the market model decreases.

5 Cross-sectional Analysis

The fixed-effect analysis results are supportive of our hypothesis that the upward trends in firm focus and the level of institutional ownership are related to the increase in idiosyncratic volatility documented in CLMX (2001). While the fixed-effects model we employ in the previous section preserves the time-series dispersion in the data, it removes cross-sectional dispersion. As a result, we cannot make inferences concerning the short-term cross-sectional dynamics of the relation between institutional ownership and idiosyncratic volatility. More simply, the question of interest is whether a change in institutional ownership is associated with a change in the level of idiosyncratic volatility.

5.1 Regression Methodology

Given that our goal is to determine the cross-sectional relation between institutional ownership and idiosyncratic volatility, one approach would be to regress the level of idiosyncratic volatility on the proportion of institutional ownership and a set of control variables. This is problematic, however, as institutions may simply prefer larger, more liquid stocks and size and liquidity covary with idiosyncratic volatility. Our solution to the endogeneity issue is to regress the lagged change in idiosyncratic volatility on the change in institutional ownership. This functional form is not new. Black (1976) and Christie (1982) explore how total volatility reacts to price changes. They find that changes in total volatility negatively covary with price changes. The standard explanation for this relation is based on leverage. A negative (positive) return increases (decreases) financial leverage which increases equity risk and increases the firm's volatility. The empirical evidence in support of the leverage effect is mixed. While the negative relation between price changes and changes in total volatility is reliably statistical negative, the relation also exits for firms with little or no debt in their capital structure.

The standard form of the regression model researchers employ in this literature is as follows:

$$\Delta\sigma = \gamma_0 + \gamma_1 return + \xi, \tag{5}$$

where $\Delta\sigma$ is the log of the ratio of total volatility in period $t+1$ to total volatility in period t and *return* is the firm's return in period t. Duffee (1995) argues that the this specification is flawed as the negative coefficient for γ_1 is driven by the contemporaneous correlation between total volatility in period t and return in period t. To address this issue, we adjust the above specification by substituting the volatility in period $t-1$ for period t volatility.

Though we employ the above methodology to test for a cross-sectional relation between idiosyncratic volatility and institutional ownership, it also provides an improved test of the leverage hypothesis. Bekaert and Wu (2000) suggest that news increases current-period market volatility and that investors update their conditional volatility priors since volatility is persistent. The update in conditional volatility forces a decline in price. The decline in price leads to higher leverage and thus greater volatility. Thus, previous tests have potentially measured both a volatility feedback and leverage effect. The volatility feedback effect, however, is only relevant for news which is systematic in nature. Hence, a measured asymmetry in idiosyncratic volatility should only occur from a leverage effect. This suggests that our use of the asymmetric volatility regression model also provides an improved test of the leverage effect.

We also add *size* and *turnover* to the standard asymmetric volatility regression to control for institutional ownership proxy effects. We delete *herfindahl* from the specification we employ in Section 4 as firm focus evolves slowly. We also delete *leverage* as *return* acts as a proxy for the change in *leverage*. To determine the cross-sectional relation between institutional ownership and idiosyncratic volatility we estimate the following cross-sectional regression:

$$\Delta\epsilon_{it} = \gamma_0 + \gamma_1 return_{it} + \gamma_2 size_{it} + \gamma_3 turnover_{it} + \gamma_4 \Delta io_{it} + \gamma_5 \Delta iom_{it} + \xi_{it}, \tag{6}$$

where the dependent variable is the natural logarithm of ratio of idiosyncratic volatility in period $t+1$ to idiosyncratic volatility in period $t-1$. The independent variables are *return* which is the market adjusted quarterly return of period t, *size* which is the market value of equity measured on the last trading day of the quarter, *turnover* which is the quarterly mean of daily volume divided by shares outstanding, Δio which is the change in io from quarter $t-1$ to t, and Δiom which is the change in iom from quarter $t-1$ to t. The results of the estimation are presented in Table V.

5.2 Regression results

Table V presents the results of three different specifications. The model in the first column presents the most basic specification. The model in the second column adds the change in institutional ownership and two control variables to the specification in the first column. The sample size declines from the first to the second column as the institutional ownership data exists only for approximately 90 percent of the CRSP universe of stocks. Finally, the model in the third column adds the change in mutual fund concentration to specification.

We will focus our discussion on the model in the third column since the sign and statistical significance of the coefficient estimates for the simpler models are the same as for the model in the last column. The coefficient for return is -0.3328 and equality of the coefficient and zero is rejected with a t-statistic of -55.07. The negative sign of the coefficient indicates that changes in idiosyncratic volatility negatively covary with return. To determine how our results compare to those in the asymmetric volatility literature, we also estimate model (6) with the change in total volatility as the dependent variable. The return variable is not market adjusted in this regression. The return coefficient is -0.3029 and is significantly different from zero. Our results are supportive of the leverage effect as a source for asymmetric volatility. This result is important as prior studies of asymmetric volatility with the exception of Bekaert and Wu (2000) implicitly jointly test both the volatility feedback and the leverage hypothesis.

The control variable results differ from those in the previous literature. Cheung and Ng (1992) find that there is a strong negative relation between conditional volatility and firm size, while we find that larger firms have smaller innovations in idiosyncratic volatility. There are, however, significant differences in study design. Chueng and Ng (1992) model total volatility in an EGARCH framework as opposed to our use of changes in volatility. Moreover, they model total rather than idiosyncratic volatility. Finally, the t-statistic for the size coefficient is 2.08 which is not large considering our sample size. The coefficient for turnover is strongly significantly negative. This differs from the existing literature (Schwert (1989)) and the time-series results from the previous section where volatility is positively related to trading volume. An important distinction is that in the previous section we examine time-series trends rather than short-term dynamics. One explanation for the negative relation between liquidity and changes in idiosyncratic volatility is that a more liquid firm can ameliorate any price effect of institutional trading. This is, of course, why institutions prefer more liquid firms.

The essential independent variable of interest is the change in institutional ownership. We include this variable to ascertain if the cross-sectional distribution of changes in idiosyncratic volatility is related to changes in institutional ownership. In addition to the change in aggregate institutional ownership, we also include the change in mutual fund concentration. The findings in Table V strongly support our hypothesis. The coefficient for the change in institutional ownership is positive (0.6607) and equality of the coefficient and zero is rejected (the t-statistic is 21.38). While the institutional ownership coefficient is statistically significant, it is also economically significant. Holding all else constant, a one standard deviation change in institutional ownership implies a three percent increase in idiosyncratic volatility, a 75 percent change. The mutual fund concentration coefficient is also positive and significantly different from zero. This result suggests that the composition of the change in mutual fund ownership is also important and is consistent with prior evidence that suggests that mutual funds are the class of institutional investors that are most likely to trade and move prices.

5.3 Robustness tests

Though the results in Table V are statistically significant, the results could be the driven by correlation among the independent variables, correlated standard errors, or a specific regression model. To make certain that our results are robust, we estimate model (6) while controlling for correlation among the independent variables, allowing for serial correlation in the error structure, and using alternative definitions of the independent variables.

One potential issue in model (6) is correlation between the independent variables. Lakonishok et al. (1992) provides evidence that institutional investors prefer large firms. Falkenstein (1996) demonstrates that mutual funds prefer liquid stocks. The correlation of institutional ownership with return, size, and turnover may indicate the results obtained from model (6) are contaminated with proxy effects. To address this issue, we orthogonalize the independent variables using a modified Gram-Schmidt (Golub and Van Loan (1989)) procedure. We orthogonalize the variables in the following order: $constant$, $return$, $size$, $turnover$, Δio, and Δiom. The ordering of the variables is important as the full effect of each variable is extracted from the following variable. For example, the procedure removes the effect of $return$ from $size$ and then removes the effect of $return$ and $size$ from $turnover$. The procedure continues until all the independent variables are orthogonal to the change in institutional ownership. Model (6) is estimated with the orthogonalized variables. While the magnitudes of the coefficient estimates differ from those presented in Table V, the sign and significance of the coefficients are unchanged. In the interest of brevity the results are not tabulated.

We also examine the independent variable matrix to ascertain if correlations among the independent variables are sufficiently high to produce sign flips. We estimate variance inflation factors for the independent variable matrix and find that the average variance inflation factor is close to one and no factor is larger than two. An informal rule of thumb suggest (Chatterjee, Hadti, and Price (2000)) that if the largest factor is less than 10 and if the mean of the factors is close to 1 then highly collinear independent variables is not an issue.

A second potential issue is serial correlation of the standard errors. Schwert (1987) demonstrates that volatility is persistent. If idiosyncratic volatility is persistent, the standard errors of the coefficients in model (6) may be biased downward. This concern is partially addressed by the fact that the dependent variable is the innovation in idiosyncratic volatility from period $t-1$ to t. This should at a minimum reduce the level of persistence in the dependent variable. Given the lagged nature of the difference, however, it is possible that some persistence remains which in turn could induce model (6) to have serially correlated errors. We address this concern in two ways. First, we estimate model (6) assuming heteroskedastic serially correlated errors. Second, we also estimate model (6) for each year and quarter and compute Fama-Macbeth (1973) t-statistics. The results are from the GLS estimation of model (6) are similar to those presented in Table V with the exception of $size$ where the parameter estimate in no longer statistically significant. In both cases, the change in institutional ownership and the change in mutual concentration are positive and significant. In the interest of brevity the results are not tabulated.

Finally, we also examine the robustness of the regression specification by estimating model (6) with alternative specifications of the independent variables. We replace the market value of equity with the book value of total assets and the change in institutional ownership with a dummy variable equal to 0 if $\Delta io < 0$ and 1 otherwise. Finally, we include two-digit SIC dummies. For brevity, the reports are not reported. The results from the alternative specifications are quantitatively and qualitatively similar to those obtained from the original specification.

5.4 Sub-sample Analysis

The volatility feedback model of Bekaert and Wu (2000) suggest that the magnitude of the volatility response will differ for positive and negative news. Basically, after positive news leverage decreases which reduces volatility. The leverage effect offsets the upward revision in conditional volatility. Figlewski and Wang (2000) document just such a differential response. They find that the absolute change in total volatility is significantly larger after a negative return relative to a positive return. It is possible that the magnitude of the institutional response to positive and negative news also differs. In Section 2 we discuss the incentives for institutional investors to display mimicking behavior. It is possible, however, that the punishment for underperformance differs when the institutional portfolio posts negative and positive returns. If the cost for not mimicking is higher when there are negative returns relative to positive returns, institutions display greater herding after negative returns. Hotchkiss and Strickland (2003) find support for our conjecture. They find that institutional investors are more likely to sell after a firm misses its earnings number. To address this possibility, we estimate model (6) for positive and negative return sub-samples. The results from this analysis are presented in Table VI.

The institutional ownership results in Table VI are not consistent with our conjecture. The coefficient for Δio is 0.3110 for the negative return sample and 0.6059 for the positive return sample. If we estimate model (6) with a dummy variable for return direction and interact the dummy with the set of independent variables, we reject equality of the Δio coefficient at the one percent level. The pattern for the Δiom is markedly different. The coefficient for Δiom is 0.1559 for the negative return sample and 0.1497 for the positive return sample and we cannot reject equality of these coefficients. It is important to note, however, that the change in institutional ownership and mutual fund concentration are positively related to the change in idiosyncratic volatility.

There is, however, an interesting result in Table VI. The return coefficient is 0.4645 for the negative return sample and -1.1467 for the positive return sample. This implies that the negative coefficient for return presented in Table V does not indicate that innovations in idiosyncratic volatility negatively covary with returns. In fact, the negative return coefficient in Table V reflects the relative magnitudes of the return coefficient for the positive return and negative return samples. The reversed signs of the return coefficients in Table VI indicate that idiosyncratic volatility declines with return. The relation between changes in idiosyncratic volatility and return differs markedly from the results contained in Figlewski and Wang (2000) who find that the change in total volatility negatively covaries with return. To confirm these results we estimate model (6) with the change in total volatility as the dependent variable. The return coefficient is -0.4073 for the negative return sample and -0.1286 for the positive return sample. This suggests that the positive relation between idiosyncratic volatility and return is not a sample issue. The results presented in Table VI are not supportive of the leverage effect. We conjecture that a reduction in asymmetric information is consistent with the negative relation between idiosyncratic volatility and return. Dierkins (1991) claims that idiosyncratic volatility is related to the level of informational asymmetry. If Dierkins' reasoning is accurate and a larger market-adjusted return reflects greater resolution of uncertainty, one could expect lower idiosyncratic volatility in the next period.

6 Concluding Comments

In this paper we examine the time-series and cross-sectional determinants of idiosyncratic volatility. Similar to CLMX (2001), we find that idiosyncratic volatility has increased over the past 20 years. In the time-series, we find that this increase in firm-level volatility is positively related to increased institutional ownership, increased firm focus, and leverage. Furthermore, the explanatory power of the market-model regression has decreased over our sample period, and is negatively related to institutional ownership, increased firm focus, and leverage.

We also conduct a cross-sectional analysis of the determinants of the changes of idiosyncratic volatility. We find that in the cross-section, changes in idiosyncratic volatility are positively related to changes in institutional ownership. These results are economically significant: A one standard deviation change in institutional ownership results in a 75% increase in idiosyncratic volatility. Furthermore, we examine how changes in ownership of equities by mutual funds is related to changes in idiosyncratic volatility. We examine mutual funds since they are the type of institution most likely to herd given their labor market concerns and myopia. We find that changes in ownership of equities by mutual funds is positively related to changes in idiosyncratic volatility after controlling for changes in institutional ownership. Last, when we condition on return, we find that there is a decrease in idiosyncratic volatility following both positive and negative returns. Hence, in the cross section our findings are inconsistent with a leverage hypothesis and are consistent with a reduction in asymmetric information following both good and bad news.

Understanding the behavior of idiosyncratic volatility is important for a several reasons. Idiosyncratic volatility is an important component of total volatility, which is needed to value options and other derivatives. Furthermore, we know that volatility is not constant, so understanding the determinants of the variation in volatility may help us to create better option pricing models. Last, a better understanding of the nature of idiosyncratic risk is valuable since recent research has shown that investors tend to hold under-diversified portfolios and that idiosyncratic risk appears to be priced.

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Table I: Summary Statistics

This table presents summary statistics for the variables used in our analysis. The variables with the exception of $herfindahl$ are measured quarterly over the period 1984 to 1997. For each variable, we provide minimums, medians, medians, and maximums. $size$ is the market value in millions of equity measured on the last trading day of the quarter, $turnover$ is the mean of daily volume expressed as a percentage of outstanding shares. $leverage$ is the book value of debt divided by book asset value. $herfindahl$ is the annual sales based Herfindahl index. io is the percentage of a firm's outstanding shares held by 13F institutions on the last day of each quarter. iom is ratio of mutual fund ownership to total institutional ownership. ϵ is the sum of the squared errors from firm level quarterly market model regressions. r is the ratio of explained sum of squares to the total sum of squares from the regression employed to estimate ϵ.

variable	minimum	median	mean	maximum	N
$size$	0.0004	62.5290	626.5290	163407.3000	362745
$turnover$	0.0001	0.0019	0.0033	0.0298	362678
$leverage$	0.0311	0.5377	0.5363	1.1866	293489
$herfindahl$	0.1037	1.0000	0.8270	1.0000	266786
io	0.0002	0.1787	0.2452	0.8692	327489
iom	0.0000	0.6610	0.6093	1.0000	327489
ϵ	0.0004	0.0445	0.1340	1.4643	363421
r	0.0001	0.0292	0.0647	0.8253	363421

Table II: Time-series Trends

This table contains the annual mean values of the variables used in our analysis. *turnover* is the mean of daily volume expressed as a percentage of outstanding shares. *leverage* is the book value of debt divided by book asset value. *herfindahl* is the annual sales based Herfindahl index. *io* is the percentage of a firm's outstanding shares held by 13F institutions on the last day of each quarter. *iom* is ratio of mutual fund ownership to total institutional ownership. ϵ is the sum of the squared errors from firm level quarterly market model regressions. r is the ratio of explained sum of squares to the total sum of squares from the regression employed to estimate ϵ.

Year	*turnover*	*leverage*	*herfindahl*	*io*	*iom*	ϵ	r
1984	0.0020	0.5147	0.8229	0.1902	0.5075	0.0653	0.0753
1985	0.0024	0.5195	0.8372	0.2038	0.5523	0.0775	0.0507
1986	0.0032	0.5273	0.8434	0.2199	0.5517	0.0902	0.0667
1987	0.0031	0.5303	0.8593	0.2233	0.5571	0.1200	0.1253
1988	0.0025	0.5362	0.8652	0.2164	0.5315	0.1118	0.0660
1989	0.0026	0.5502	0.8696	0.2248	0.5153	0.1036	0.0553
1990	0.0025	0.5546	0.8698	0.2320	0.5630	0.1843	0.0738
1991	0.0027	0.5645	0.8718	0.2391	0.6193	0.2065	0.0633
1992	0.0032	0.5336	0.8748	0.2545	0.6632	0.2187	0.0433
1993	0.0038	0.5222	0.8810	0.2685	0.6901	0.1836	0.0386
1994	0.0038	0.5425	0.8883	0.2802	0.6794	0.1548	0.0537
1995	0.0042	0.5484	0.8955	0.2865	0.6846	0.1513	0.0397
1996	0.0049	0.5406	0.8985	0.2989	0.7178	0.1369	0.0378
1997	0.0049	0.5327	0.8917	0.2954	0.7285	0.1424	0.0414

Table III: Time-Series Volatility Regressions

The dependent variable is either $\bar{\epsilon}$ which is the sample mean of the sum-of-squared errors from firm-level quarterly market-model regressions or $\bar{r}$ which is the sample mean of the ratio of explained sum of squares to the total sum of squares from the regression employed to estimate ϵ. The independent variables are t which is a trend variable which takes a value of 1 for the 3^{rd} quarter of 1962 and increases by 1 for each quarter until it reaches 142 for the 4^{th} quarter of 1997 and t_d which is a year dummy which takes a value of 0 for years prior to 1980 and 1 otherwise. The coefficient estimates are shown on the first line and t-stats are in parentheses.

variable	$\bar{\epsilon}$	$\bar{\epsilon}$	$\bar{r}$	$\bar{r}$
constant	0.0167	0.0512	0.1116	0.0983
	(3.09)	(11.23)	(15.94)	(19.79)
t	0.0009		-0.0004	
	(14.06)		(-4.70)	
t_d		0.0626		-0.0303
		(9.78)		(-4.35)
R^2	0.5859	0.4095	0.1319	0.1140
N	142	142	142	142

Table IV: Fixed Effect Idiosyncratic Volatility Regressions

This table reports coefficient estimates from a fixed-effect regression of the following form:

$$y_{it} = \gamma_i + \gamma_1 size_{it} + \gamma_2 turnover_{it} + \gamma_3 leverage_{it} + \gamma_4 herfindahl_{it} + \gamma_5 io_{it} + \gamma_6 iom_{it} + \xi_{it}$$

The dependent variable is either ϵ which is the sum-of-squared errors from firm-level quarterly market-model regressions or r which is the ratio of explained sum of squares to the total sum of squares from the regression employed to estimate ϵ. The index i represents a firm. The index t represents a quarter. The independent variables are *size* which is the natural logarithm of the market value of equity measured on the last trading day of the quarter, *turnover* which is the mean of daily volume expressed as a percentage of outstanding shares, *leverage* which is the book value of debt divided by book asset value, *herfindahl* which is the annual sales based Herfindahl index, *io* which is the percentage of a firm's outstanding shares held by 13F institutions on the last day of each quarter, and *iom* is ratio of mutual fund ownership to total institutional ownership. The coefficient estimates are shown on the first line and t-stats are in parentheses.

variable	ϵ	ϵ	r	r
size	-0.1210	-0.1222	0.0153	0.0155
	(-77.10)	(-77.10)	(50.34)	(50.50)
turnover	0.9911	1.0470	1.4338	1.4972
	(3.85)	(3.99)	(28.76)	(29.30)
leverage	0.1262	0.1251	-0.0095	-0.0095
	(24.66)	(24.51)	(-9.56)	(-9.54)
herfindahl	0.0556	0.0543	-0.0117	-0.0113
	(5.79)	(5.58)	(-6.27)	(-6.07)
io	0.2566	0.2425	-0.0380	-0.0367
	(26.63)	(25.15)	(-20.39)	(-19.52)
iom		0.0573		-0.0085
		(11.54)		(-8.83)
R^2	0.2929	0.2962	0.0486	0.0494
N	231130	231130	231130	231130

Table V: Cross-Sectional Volatility Change Regressions

This table reports coefficient estimates from an OLS regression of the following form:

$$\Delta\epsilon = \gamma_0 + \gamma_1 return + \gamma_2 size + \gamma_3 turnover + \gamma_4 \Delta io + \gamma_5 \Delta iom + \xi$$

The dependent variable is the natural logarithm of $\epsilon_{t+1}/\epsilon_{t-1}$ where ϵ is the sum of squared errors from a market model regression. The independent variables are *return* which is the market adjusted quarterly return of period t, *size* which is the natural logarithm of the market value of equity measured on the last trading day of the quarter, *turnover* which is the mean of daily volume expressed as a percentage of outstanding shares, Δio which is the change in the percentage of a firm's outstanding shares held by 13F institutions from quarter $t-1$ to t, and Δiom which is the change in the ratio of mutual fund ownership to total institutional ownership from quarter $t-1$ to t. The coefficient estimates are shown on the first line and heteroskedastic consistent t-stats are in parentheses.

variable	$\Delta\epsilon$	$\Delta\epsilon$	$\Delta\epsilon$
constant	0.0355	0.0442	0.0456
	(24.52)	(3.11)	(3.19)
return	-0.3394	-0.3305	-0.3328
	(-60.93)	(-54.99)	(-55.07)
size		0.0017	0.0016
		(2.15)	(2.08)
turnover		-13.3155	-13.5606
		(-41.91)	(-42.07)
Δio		0.6529	0.6607
		(21.14)	(21.38)
Δiom			0.1679
			(13.00)
R^2	0.0109	0.0175	0.0182
N	336212	296948	296948

Table VI: Cross-Sectional Return Direction Volatility Change Regressions

This table reports coefficient estimates from an OLS regression of the following form:

$$\Delta\epsilon = \gamma_0 + \gamma_1 return + \gamma_2 size + \gamma_3 turnover + \gamma_4 \Delta io + \gamma_5 \Delta iom + \xi$$

The dependent variable is the natural logarithm of $\epsilon_{t+1}/\epsilon_{t-1}$ where ϵ is the sum of squared errors from a market model regression. The model is estimated using negative and positive return samples. The independent variables are *return* which is the market adjusted quarterly return of period t, *size* which is the natural logarithm of the market value of equity measured on the last trading day of the quarter, *turnover* which is the mean of daily volume expressed as a percentage of outstanding shares, Δio which is the change in the percentage of a firm's outstanding shares held by 13F institutions from quarter $t-1$ to t, and Δiom which is the change in the ratio of mutual fund ownership to total institutional ownership from quarter $t-1$ to t. The coefficient estimates are shown on the first line and heteroskedastic consistent t-stats are in parentheses.

variable	$\Delta\epsilon$	$\Delta\epsilon$	$\Delta\epsilon$	$\Delta\epsilon$
	$return < 0$	$return < 0$	$return > 0$	$return > 0$
constant	0.1877	1.0912	0.1650	0.0094
	(61.93)	(45.74)	(64.82)	(0.83)
return	0.4054	0.4645	-1.1713	-1.1467
	(37.61)	(37.26)	(-109.74)	(-94.68)
size		-0.0480		0.0076
		(-37.13)		(7.54)
turnover		-13.6578		0.8528
		(-24.84)		(2.08)
Δio		0.3110		0.6059
		(6.26)		(15.78)
Δiom		0.1559		0.1497
		(8.07)		(9.34)
R^2	0.0089	0.0288	0.0429	0.0612
N	156728	159865	179484	137083

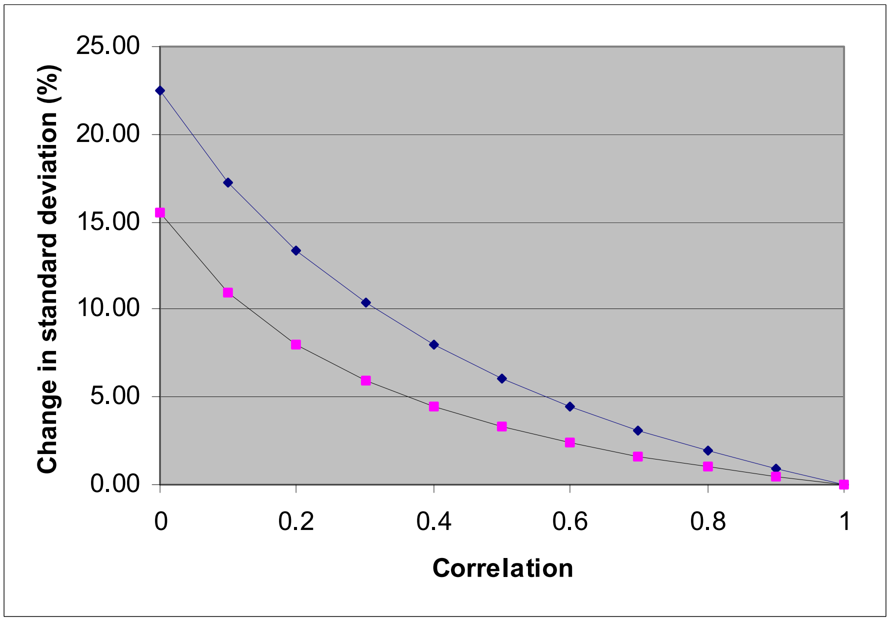

Figure 1: This figure shows the percentage increase in the standard deviation of the returns of a firm's equity when the firm focuses from three segments to two segments (top line with diamonds) and when the firm focuses from four segments to three segments (bottom line with squares) as a function of the correlation between the business segments. For example, if all segments of a three-segment firm have a correlation of 0.5, then divesting one of these segments results in an increase in equity volatility of 6% per year, from a standard deviation of 16.3% to 17.3% per year. Each individual business segment has a standard deviation of returns of 20% per year, and all segments have an equal weight.