Long-run Volatility and Risk Around Mergers and Acquisitions*

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Abstract

In this paper we study the changes in volatility and risk of acquirers around mergers and acquisitions (M&As) and seek to understand the determinants of those changes. We find there is a strong run-up in volatility and risk beginning four years before the merger. This pre-merger run-up is consistent with the view that M&As are a response to industry shocks as documented by Mitchell and Mulherin (1996). We find that for a period of about one year after the merger the cross-sectional average of the volatility measures (total, systematic and idiosyncratic) continue to increase. Beyond one year the systematic volatility and beta begin to decline but total and idiosyncratic volatilities do not. The post-merger volatility pattern is consistent with the notion that the risk of integration of the acquirer and the target firms gets resolved over time. Interestingly, there is no difference between the volatility patterns of intra- and inter-industry mergers. Our findings have important implications for understanding several issues, including the announcement wealth effect of mergers, changes in the diversification discount, and the long-run underperformance of acquirers in M&A transactions.

Keywords: Mergers and Acquisitions, Volatility, Risk, Diversification, Long-run Underperformance

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1 Introduction

In 2000, the dollar volume of worldwide corporate Mergers and Acquisitions (M&A) announcements was $3.2 trillion covering more than 3,000 transactions. Of these transactions, approximately half involved U.S. corporations, and U.S merger activity as a percentage of U.S. GDP was as high as 18% (Bruner (2004)). Given the importance of M&A in the economy, a large literature has studied the wealth effects of M&A announcements on acquirers using event studies and long-run performance measurement methods. The general consensus from event studies is that acquiring firms' shareholders experience significantly negative abnormal returns around the announcement dates[1]. The evidence on five-year long-run stock returns following M&As suggests that acquirers have significantly negative long-run returns (Loughran and Vijh (1997)). Taken together, all these studies point to a value loss in M&A transactions both in the short term and in the long term.

Although stock returns and wealth effects of an acquirer around an M&A transaction have been extensively studied, there has been very little study on long-run changes in volatility and risk around a merger event.[2] After all, the value of any asset (in our case, the acquiring firm) depends mechanically on the asset's expected future cash flows and expected future returns. Expected returns depend upon the risk and volatility of the acquiring firm. Many of the existing explanations of negative announcement returns for acquirers focus on inefficient use of firm cash flows, including over-payment (Roll (1986)) and wasteful investment by empire building managers (Jensen (1986)). Behavioral theories focus on overvaluation of the acquirer's stock and the subsequent correction in the market's valuation to explain the negative returns (Shleifer and Vishny (2003), and Rhodes-Kropf and Viswanathan (2005)).

Studying volatility and risk changes may be important in understanding the announcement wealth effects and the long-run returns following mergers. To the extent that ac-

[1] See Moeller, Schlingemann and Stulz (2003, 2004) for recent evidence including the finding that large acquirers destroy more value than small acquirers.

[2] Jayaraman, Mandelker and Shastri (1991) study the short-run changes in volatility (-160, +2 days) of targets around a merger using a sample of 27 firms.

quisitions might increase the volatility of cash flows of the combined firm, the negative announcement wealth effects documented in the literature might also be consistent with the view that markets recognize the increase in risk of the post-merger firm. If the increase in volatility risk is priced, investors would demand higher expected returns from the acquirer. This can result in an immediate drop in the stock price. Similarly, long-run returns might also be related to long-run changes in volatility and risk of the acquiring firm.

In this paper we study the changes in long-run volatility and risk of acquirers around a merger event and seek to understand the determinants of those changes. We begin by studying the changes in volatility and risk of the equity of all U.S. acquiring firms that undertook a merger transaction between the fourth quarter of 1995 and the third quarter of 2002. In an important innovation in the empirical study of mergers and acquisitions, we use volatility implied in an option's price as our estimate of total volatility rather than using volatility computed from realized returns. Implied volatility is regarded as the option market's forecast of future return volatility over the remaining life of the relevant option. As Christensen and Prabhala (1998) show, implied volatility outperforms past volatility computed using realized returns data in forecasting future volatility and subsumes the information content of past volatility. Implied volatility is also free from the contamination of event period returns in the estimation of post-merger return volatility. We decompose our acquirer total implied volatility (hereafter referred to as total volatility) into systematic and idiosyncratic components.

We find there is a strong run-up in all three measures of volatility (total, systematic and idiosyncratic respectively) and risk (beta) leading up to the merger. In a four-year period leading up to the merger the run-up in the average total, systematic and idiosyncratic measures of volatility are about 13, 7 and 10 percentage points, respectively. The cross sectional average beta increases from 1.02 to 1.21 during the same period. There is also a strong statistically and economically significant increase in all these measures in the quarter after the merger as compared to the quarter before the merger. For a period of one year after the

merger, the cross-sectional averages of the volatility measures and beta continue to increase. However, both systematic volatility and beta begin to decline one year after the merger. In contrast, total and idiosyncratic volatility do not seem to decline. We perform a series of robustness checks to confirm that these results are not due to a market-wide volatility pattern or the specific sample period of our data.

We then turn to some interpretation of our results. The notion of industry shocks arising from unexpected changes in demand, technology, movements in capital markets and changes in entry barriers has been used to rationalize merger waves and the clustering of M&A activity within industries (Gort (1969)). Mitchell and Mulherin (1996) and Harford (2004) find empirical support for this view using merger activity data in the 1980s and the 1990s. We construct a measure of industry shocks for each acquirer in event time following Mitchell and Mulherin (1996) and find a pattern of run-up in industry shocks similar to the volatility run-up patterns uncovered above. When we regress changes in volatility on the changes in industry shocks we find that industry shocks are significant in explaining the pre-merger increases in volatility. We conclude that the pre-merger run-up in volatility is consistent with the notion of industry shocks experienced by the acquirer firms prior to the merger.

There are at least three factors that may determine the level of post-merger volatility of the acquirer. First, as we outlined above, mergers are a response to industry shocks faced by firms. Thus a successful merger may lead to a post-merger decline/stabilization in volatility. Second, one of the most crucial aspects that determines the success or failure of the merger is the ability of acquirer management to unify both the target and acquirer into a single entity after the merger. Thus post-merger integration risk is an important issue that has to be factored in by the financial markets. Based on this argument, we should expect declines/no further increases in volatility with the successful integration of the acquirer and the target. Third, the cash flows of the acquirer and the target are imperfectly correlated. Based on the principle of diversification and portfolio theory, we expect acquirers to have declines in volatility immediately after the merger. This decline is likely to be greater for mergers across

industries (inter-industry mergers).

The short-run first-year increase in all our volatility and risk measures suggests the impact of post-merger integration risk might outweigh any diversification benefits in the immediate aftermath of a merger. Beyond the first year, beta and systematic volatility begin to decline while the total and idiosyncratic volatilities do not. This suggests the merger may be working as a response to industry shocks (to reduce volatilities) but that integration risk takes longer to get resolved. Surprisingly, these patterns are the same for both intra- and inter-industry mergers, the opposite of what we would expect according to portfolio theory. Therefore, we interpret these patterns as consistent with the notion of post-merger integration risk that gets resolved over time rather than diversification benefits driving the results.

Finally, we discuss the implications of our results for the announcement wealth effect for acquirers and their long-run underperformance following a merger. We also explore the implications of our results in some detail for the diversification discount literature. Inter-industry M&As made by single-segment firms convert them into diversified firms. During our sample period, we find that about one-third of the firms in the yearly cross-sectional sample used by diversification discount studies had a merger the same year. The entire sample of diversification discount studies consists of firms that have undertaken mergers and acquisitions in the previous three to five years. Since the change in risk and volatility for the acquirer lasts for several years after a merger, as discussed above, we ask if these findings affect the changes in diversification discount over time. We find that excess value measures computed based on asset multiples following Berger and Ofek (1995) are decreasing for the four-year period (-2, +2) around the merger. However, during the same period the cash flows of these firms show a V-shaped pattern centered on the year of the merger, i.e., cash flows decline in the run-up to the merger and rebound sharply afterward. Our findings of increased risk and volatility following a merger is consistent with the notion of higher expected returns for these firms, leading to a deepening of the diversification discount over time. Consistent with this view, Lamont and Polk (2001) show that diversified firms in general have higher expected returns

than single-segment firms.

The paper is organized as follows. In section 2 we describe our sample, compute the three measures of volatility and document the patterns of volatility and risk of acquiring firms around M&A announcement dates. In section 3, we provide interpretations of the findings. We study the determinants of changes in volatility and provide evidence that industry shocks and post-merger integration risk are related to the observed volatility patterns. In section 4, we discuss the implications of our results for the wealth effects in merger event studies, the literature on long-run underperformance following mergers and the diversification discount literature. We conclude in section 5.

2 Sample Selection and Estimation of Volatility Measures

The sample of mergers and acquisitions is obtained from the Securities Data Company's (SDC) U.S. Mergers and Acquisitions Database. We select all mergers and acquisitions with announcement dates between the fourth quarter of 1995 and the third quarter of 2002. The choice of the sample period is dictated by the availability of data on the implied volatility of at-the-money call options on the acquirer (discussed in more detail below). We also require i) that all mergers have been completed, ii) a public or private U.S. firm or a non-public subsidiary of a U.S. firm is acquired, and iii) the acquirer is a public firm included in the Center for Research in Security Prices (CRSP) database during the event window. We obtain the deal value, which is defined by SDC as the total value of consideration paid by the acquirer, excluding fees and expenses. We also collect information on whether a transaction is a tender offer, a friendly or hostile acquisition, paid for fully by cash or stock, and whether the target and the acquirer are in the same Fama-French (1997) industry classification or not.

2.1 Summary Statistics

Our sample selection yields 8,139 successfully completed acquisitions during this period. Table 1 shows that both the number of deals as well as the deal value steadily increase from 1995 to 1999 before declining in the latter part of the sample period. Table 1 also shows that about 3% of total deals are tender offers which is consistent with the low number of tender offers reported in other studies such as Loughran and Vijh (1997). About 31% of the deals are fully financed with cash and 14% with stock. The remaining deals use a mix of stock and cash as the method of payment. About 43% of the deals are inter-industry (i.e., diversifying) mergers.

2.2 Volatility and Risk Measures

We focus on implied volatilities of at-the-money call options on the equity of the acquirer in order to obtain a total measure of volatility (measured in quarters relative to the merger event).[3] The total volatility implied in an option's price is regarded as the option market's forecast of future return volatility over the remaining life of the relevant option. Implied volatility is interpreted as an efficient volatility forecast in a wide range of settings (see, for example, Day and Lewis (1988); Poterba and Summers (1986)). The availability of implied volatility data dictates the choice of our sample period. We have more than 6,000 firm acquisitions with implied volatility data on the event date.[4]

We obtain the implied volatility of 30-day at-the-money call options from the IVY Database

[3]Qualitatively our results are not sensitive to choice of the maturity of the option. However using long maturity options such as a 365-day option introduces issues due to the relative lack of liquidity that must be addressed.

[4]Our study of volatility dynamics around mergers also contributes to a growing literature on stock market volatility. A large number of papers focus on the time series estimation of volatility, often by using stochastic volatility models and the autoregressive conditional heteroscedasticity (ARCH) models [see Bollerslev, Chou, and Kroner (1992) for a review, and Andersen et al. (2005) for recent developments in the field.]. Papers such as Schwert (1989), Campbell and Hentschel (1992), and Bekaert and Harvey (1995) have shed considerable light on the dynamics of market and portfolio volatility by linking it to macroeconomic activity, leverage and stock market trading activity. Our paper studies volatility of individual acquirer firms around mergers and acquisitions.

of Optionmetrics LLC. IVY is a comprehensive database of historical price, implied volatility and sensitivity information for the entire U.S. listed index and equity options market and contains approximately six years' worth of historical data beginning in January 1996. The implied volatilities are calculated by Optionmetrics in accordance with the standard conventions used by participants in the equity option market using a Cox-Ross-Rubinstein binomial tree model which is iterated till convergence of the model price to the market price of the option. We match the CUSIP numbers of the acquirer to the IVY database in order to obtain the time series of impled volatilities of each acquirer. Although the number of acquirers for whom the implied volatility data is available changes through time, information is available for as many as about 6,800 acquisitions on the event date.

We then proceed to break down the implied volatility (total volatility) into systematic and idiosyncratic components. The CAPM implies that

$$R_{it} = \beta_{im} R_{mt} + \epsilon_{it}$$
$$\sigma_i^2 = \beta_{im}^2 \sigma_m^2 + \sigma_\epsilon^2$$

where R stands for the return in excess of the risk free rate, σ for the volatility and the subscript i and m stand for the firm i and the market respectively.

We use the average implied volatility of 30-day at-the-money call options each quarter as an estimate of σ_i for each firm in that quarter. For an estimate of σ_m we obtain the average VIX index in that quarter. VIX is a volatility index computed by the Chicago Board Options Exchange. It is calculated by taking a weighted average of the implied volatility from eight calls and puts on the S&P 100 index and is used widely as a measure of market volatility. We estimate the β of each stock using the returns data from the CRSP database for each quarter, relative to the event time using the Scholes and Williams (1979) correction for non-synchronous data. Idiosyncratic volatility is defined as the square root of the difference of the squared implied and squared systematic volatility, whenever the difference is greater than zero.[5]

[5]For a small fraction of implied volatilities the difference is negative, so idiosyncratic volatility is not defined. We drop these

We estimate the cross-sectional averages of the three volatility measures (total, systematic and idiosyncratic) and beta in event time where event time is in quarters relative to the event date, which is the announcement of the acquisition. We study a time period of 16 quarters (four years) before and after the acquisition. Table 2 and Figure 1 document the behavior of these measures in event time. The most striking feature of the three volatility measures and beta is the strong run-up leading up to the merger. In a four-year period leading up to the merger, the run-up in the average total, systematic and idiosyncratic measures of volatility is about 13, 7 and 10 percentage points, respectively. The cross sectional average beta increases from 1.02 to 1.21 during the same period. There is a strong statistically and economically significant increase in all these measures in the quarter after the merger as compared to the quarter before the merger.

For a period of one year after the merger, the cross-sectional averages of the volatility measures and beta continue to increase. However, both systematic volatility and beta begin to decline in the year after the merger. The decline from year one to year three following the merger for systematic volatility is about 3 percentage points. The decline in beta for the corresponding period is 0.16, from 1.24 to 1.08. In contrast, total and idiosyncratic volatility do not seem to decline during the same period. By year four after the merger all these measures have stabilized.

In order to make sure this pattern is not due to a market-wide volatility pattern or the specific sample period, we construct volatility measures for two matched samples. The first matched sample uses the VIX measure. The second uses total volatility from firms NOT involved in any merger activities. This sample is constructed as follows. For each calendar quarter we obtain the total assets of all firms in the COMPUSTAT database but not in our merger sample for which the implied volatility data is available. We then classify each firm into deciles and obtain the median asset value break point for each decile. For each firm in

observations. Our results are similar if we assume those idiosyncratic volatility to be zero.

the merger sample, we assign it to the decile that is the closest corresponding one in terms of asset value. We eliminate all matches where the difference in asset values between the merger firm and the corresponding median asset value of the matching decile is greater than 10%. We then obtain the cross sectional average volatility of the matched sample in event time for comparison with the merger sample. The medians of the two matched samples were plotted in the top two panels of Figure 1. Although there is some positive drift in volatility we do not find the same volatility patterns for the matched samples.

It is possible that our results are driven either by a few outlier firms that influence cross-sectional averages or by the changing composition of the acquirer sample over time. In order to address this issue we conduct a more stringent test. We compute the year-on-year change in all our measures for the ***same*** firm in event time. We then assess the statistical significance of these changes. These results are presented in Table 3. Panel A shows that acquirer total volatility change (implied volatility) for each year-on-year period from year four before the merger is positive and significant at the 1% level (both mean and median) and for up to one year after the merger, consistent with the findings in Figure 1 and Table 2. The results of year-on-year changes in systematic and idiosyncratic volatilities and beta also formally confirm the patterns uncovered in Table 2.

We now consider the short-run changes in volatility and risk measures of the acquirer around the merger. The row (-0.25, +0.25) in the different panels of Table 3 reports the changes in these measures as the difference between the value one quarter after the merger to the value one quarter before the merger. It is important to note that there is short-run increase in each of the four measures following a merger. The increase over the two-quarter period is large in magnitude as compared to the year-on-year changes and is statistically significant at the 1% level. For example the mean (median) change in total volatility is 1.73 (1.64) in percentage points. Collectively the results in Table 3 indicate there are significant short-run increases in risk and volatility around a merger event.

To the extent that these changes in risk are priced via an increase in expected return demanded by investors, we might have another channel for explaining the value loss of acquirers at announcements of M&A transactions. In addition to the cash flow effects identified by Jensen (1986) and Roll (1986) as discussed in the introduction, the increase in expected returns due to the increase in risk can also cause a decline in the value of the acquirer. This can help explain the negative acquirer wealth effects found in earlier studies. If managers make appropriate risk return tradeoffs while choosing targets for M&A, the increase in expected returns might not have any effect on the value, offset by the expected increase in cash flows. Thus, the relative importance of these two effects (the cash flow and the discount rate effects) in explaining the negative wealth effects is an interesting research question beyond the scope of the current paper.

2.3 Combined Acquirer and Target Analysis

We have focused our analysis on the acquirer before and after an M&A transaction. However, investors in capital markets have the ability prior to the merger to combine the target and acquirer shares in their own portfolios and achieve the same effect that the merger merely formalizes. In order to address this issue we examine the value-weighted portfolio (by market value weights) of the acquirer and the target before the merger and the acquirer itself after the merger. Portfolio theory suggests that the portfolio variance of the two stocks is given by

$$\sigma_{a,t}^2 = w^2\sigma_a^2 + (1-w)^2\sigma_t^2 + 2w(1-w)\rho_{a,t}\sigma_a\sigma_t$$

where a and t stand for the acquirer and the target respectively, and w is the relative size of the acquirer. If the relative size of the acquirer is very large (close to 1), examining the acquirer is almost the same as examining this portfolio. We estimate the correlation between the target and the acquirer $\rho_{a,t}$, using the daily return data each quarter for both firms from the CRSP database. Once we obtain the total volatility of the portfolio, we can estimate the systematic and idiosyncratic components as before.[6]

[6]The beta for the portfolio before the merger is the weighted average of the betas of the acquirer and the target.

Since this calculation requires that the implied volatility of at-the-money call options of both the acquirer and the target be available in event time, we lose a lot of observations in our sample. We are able to obtain about 144 merger events with volatility data as on the event date. Note that these targets are most likely to be bigger than an average target since they have options traded. As we argue above, the pre-merger portfolio volatilities are likely to be significantly different from those of the acquirers alone only when the targets are large. For smaller targets, acquirer volatility is a good proxy for the volatility of the portfolio of the acquirer and the target. The results based on acquirer-target portfolio volatility are presented in Table 4. As can be seen, all three measures of volatility broadly follow patterns similar to that of Table 2 even though the number of observations decline rapidly in event time beyond year three after the merger. For example, both total and idiosyncratic measures of volatility feature a run-up in volatility prior to the merger, followed by an increase after the merger for up to two years and a decline thereafter.

3 Explanations of the Patterns

3.1 Pre-Merger Period

What could explain these patterns of volatility and risk around merger events? The notion of industry shocks arising from unexpected changes in demand, technology, movements in capital markets and changes in entry barriers has been used to rationalize merger waves and the clustering of M&A activity within industries (Gort (1969)). We hypothesize that the pre-merger run-up is related to the industry shocks experienced by firms. We show below that the patterns of industry shocks for acquirer firms are consistent with the patterns of volatility and risk. The pre-merger run-ups in volatility and risk are clearly big by any standards and suggest mergers and acquisitions as a possible mechanism used by managers to address the run-up in risk. Lambrecht (2002) studies the effect of industry shocks in the framework of real options and argues that firms have the option to acquire instead of

growing organically. Industry shocks increase the uncertainty or volatility of the firms' asset values. Hence the value of the option to merge also increases. This induces a rise in merger activity as a response to industry shocks. According to Mitchell and Mulherin (1996) the industry level shocks are likely to persist for some time, so merger activities may predict subsequent higher volatility levels. If the M&A is successful as a response to the industry shocks, then we would eventually see less of an increase in volatility or even lower volatility levels. Recent evidence by Harford (2004) also corroborates this industry shocks view by suggesting that merger waves are driven by industry shocks based on a sample of mergers in the 1980s and 1990s. He finds that there must be sufficient capital liquidity in order to generate a large volume of transactions (merger wave) to accompany the economic shocks.

Figure 2 shows the pattern of industry shocks. For our sample of merger events we plot the cross sectional mean of corresponding industry shocks (for the acquirer's industry) as computed by Mitchell and Mulherin (1996). Their measure gauges the shocks in an industry by computing the economic change experienced by the industry's members. For each of the Fama-French (1997) industries in our merger sample, we use Compustat data to first compute industry year-on-year sales growth. For the measure of the industry sales shock, we then take the absolute value of the difference between a particular industry's sales growth and the average sales growth across all Fama-French (1997) industries. This measure corresponds to the idea of a shock, because it emphasizes that shocks can have both positive and negative effects on industry growth. We see from Figure 2 that the pattern is clearly upward sloping and remarkably similar to the run-up in all the volatility measures observed before the merger.

Panel A of Table 5 provides the summary statistics of industry shocks (cross sectional averages) in event time for all acquirers. The shocks continually rise from a level of 5.56% four years before the merger to 6.73% in the year of the merger. To formally examine the link between industry shocks and our volatility measures, we regress the change in volatility (total, systematic and idiosyncratic) for each firm from year 3 to year 1 before the merger

against the change in industry shocks over the same period. The choice of the period is to maximize the number of data observations while not being too close to the merger event. We expect a positive and significant coefficient on the industry shock variable to be consistent with the theory. Panel B of Table 5 reports the regression results. We find the coefficient on changes in industry shocks to be positive and statistically significant (at the 1% level of significance) in the regression of changes in total and idiosyncratic volatilities. However, in the regression of the change in systematic volatility, we find the coefficient to be negative and marginally significant (at the 10% level of significance). This suggests that industry shocks mainly affect the total volatility through the change in idiosyncratic volatility. This is also consistent with the observation of Schumpeter (1947) that M&A activity is driven by turbulence at the level of the firms and the industry, not at the level of the economy.[7] We also examine if the volatility patterns are due to the change in leverage of our sample firms. We compute the correlations between leverage and our measures of volatility and found them to be very close to zero. Further, the leverage in event time does not follow the same pattern of volatilities.[8]

3.2 Post-Merger Period

There are three factors that may affect the level of volatility and risk of acquirers in the post-merger period. They are (a) M&A as a successful response to the industry shocks faced by the acquirers in the pre-merger period, (b) the risk of successful integration of the acquirer and the target, and (c) the benefits of diversification due to imperfectly correlated cash flows of the acquirer and the target.

[7] Industry shocks are likely to lead to higher volatility of profitability for firms in the industry (Pastor and Veronesi (2003)). We compute the mean of volatility of profitability in event time and find it to follow a pattern similar to that of industry shocks.

[8] To conserve space we do not report these results, which are available on request.

3.2.1 Industry Shocks

The discussion on volatility patterns in the pre-merger period suggests that mergers are a response to industry shocks that get reflected in the volatility run-up before the merger. Thus, the post-merger pattern of increases in the volatility measures in the year following the merger is also consistent with the persistence of industry shocks for a period of time following the merger. In the year after the merger, total and idiosyncratic volatility levels increase but stabilize at those levels beyond year one. This pattern is consistent with the view that industry shocks persisting for a period of time even after the merger is a response by the acquirer firm to address the increase in those shocks.

3.2.2 Integration Risk

The post-merger integration of acquirer and target is also related to the pattern of volatility for the post-merger period. One of the most crucial aspects that determines the success or failure of the merger is the ability of the acquirer management to unify both the target and the acquirer into a single entity after the merger. Termed Post Merger Integration (PMI), most companies have turned to integration managers – usually mid- to upper-level executives relieved of their customary duties – to help lead the task of integrating companies after an M&A (Shelton (2003)). Specific aspects of organizational integration include board, management, staff, programs, human resources, marketing, and information systems. According to Bruner (2004), integration planning begins before the announcement of a definitive deal agreement. The goal is to create detailed implementation plans on the organizational issues complete with milestones for making the merger work as quickly as possible. The uncertainty generated by a merger creates the environment in which the post-merger integration strategy must be executed. Thus post-merger integration risk – the possibility that an M&A deal may fail to achieve the desired objectives in this process – is an important issue that has to be factored in by the financial markets. This risk persists over the entire integration phase, which can be as long as several years. Bruner (2004) presents a case study of the merger of Union Bank of Switzerland and the Swiss Bank Corporation in which the integration phase

was as long as two years since the announcement of the merger.

We first hypothesize that acquirers that undertake multiple acquisitions in succession will have to face higher post-merger integration risk. With multiple targets the integration process will be longer and there will be more associated uncertainties. This suggests that multiple acquirers will face a period of sustained increase in volatility following an acquisition that will take longer to get resolved compared to single acquirers.

Panel A of Table 6 shows that of the 1,705 unique acquirer firms in our sample, the median firm undertook three deals over the sample period. The median time period between deals is about four months. This means that even as the post-merger integration risk of a deal is getting resolved, a new deal would contribute to increasing the risk of the acquiring firm. In Panel B we divide the firms into quartiles based on the number of acquisitions made during our sample period. Quartile 4 firms made the greatest number of acquisitions and Quartile 1 firms the least. We then tabulate the firm-specific characteristics of these acquirers. Panel C shows that multiple acquirers are bigger (higher market capitalization), have lower growth opportunities (Q ratio), lower R&D to Sales, higher profitability and leverage as compared to the firms that make the least number of acquisitions. This is consistent with the profile of bigger mature firms with less growth opportunities seeking growth through acquisitions.

Figure 3 shows the total, systematic and idiosyncratic volatilities in event time for acquirers sorted into quartiles based on the number of acquisitions. It can be seen that the level of volatility (all three measures) of the acquirers is monotonically decreasing in the number of acquisitions made (i.e., multiple acquirers have the lowest volatility levels). As the number of acquisitions increases, the decrease in volatility measures following the merger is shifted to the right (i.e., occurs at a later point in time). For the firms in Quartile 4, there does not appear to be any decline in total volatility. In contrast, the volatilities of acquirers in Quartile 1 begin to decline one year after the merger. Therefore, the more acquisitions an acquirer has, the later the decline in volatilities would occur. Thus, this is consistent with the view

that the increase in volatility following a merger is at least in part due to post-merger integration risk, and the risk is greater and lasts longer for firms that make multiple acquisitions.

In order to further assess the role of integration risk in the observed post-merger volatility patterns, we examine the role of the relative size of the target to the acquirer on the increase in our measures of volatility following a merger. We expect that if the target is very small relative to the acquirer, the post-merger integration risk is likely to be lower; and thus we do not expect to see a significant increase in our volatility measures following the merger. We define relative size as the ratio of the average market capitalization of the target to the sum of the average target and acquirer market capitalizations. The average is computed over the calendar year preceding the merger year. Due to data limitations, this produces 962 cases. Firms are then sorted into two groups below and above the median relative size of the target: relative size small and relative size large, respectively. Similarly, the top two quartiles of the firms based on the number of acquisitions made are classified as frequent acquirers and the bottom two quartiles as infrequent acquirers. Each merger deal is then classified into one of the four groups based on the relative size and the frequency of the acquisitions. Panel A of Table 7 reports the distribution of relative size and number of acquisitions (count) in these four groups.

Panel B of Table 7 reports the difference in total volatility for the same firm between quarter 1 and quarter 8 following the merger in event time. The choice of quarters 1 to 8 is to ensure that at least 30 data points are available in all the four groups for analysis. Figure 4 provides the time series of total volatility in event time for up to 16 quarters after the merger. From Figure 4, we see that among infrequent acquirers and a small target, there is a rapid decline in total volatility following the merger. It takes much longer for volatility to decline when the target is relatively large. Statistical tests of the mean reported in Panel B of Table 7 suggest that the decline for small targets is about 14.1% and significant at the 1% level. However, for the relatively large targets the decline is indistinguishable from zero. These results suggest that it is difficult to integrate a large target as quickly as a small one.

The results for frequent acquirers, as shown in the bottom panel of Figure 4, is striking. Regardless of the relative size of the target (small or large), frequent acquirers experience a steady increase in total volatility in the years following the merger. Statistical tests of the mean suggest that the increase in acquirer volatility for relatively large targets is about 4.6% and significant at the 1% level. However, the volatility change is indistinguishable from zero for the relatively small targets. These results suggest that regardless of the size of the target, volatility does not decline (small targets) or continues to increase (large targets) among frequent acquirers. These results provide further support for the notion of post-merger integration risk that gets resolved over time. The integration process lasts longer when the acquirer makes multiple acquisitions and when the targets are relatively large.

3.2.3 Diversifying Mergers

The acquirer and target firms have imperfectly correlated cash flows. The principle of diversification suggests that firms in different industries are more likely to have less correlated returns and cash flows. This would then lead to a lower volatility for the combined firm, which is really a portfolio of the acquirer and the target. Thus from a portfolio diversification perspective we expect to see (i) a decline in volatility following any merger and (ii) a greater decline in our volatility measures following a merger, for inter-industry mergers as compared to intra-industry mergers (which are among firms in the same industry and hence more likely to be correlated). The result that all mergers have an increase in volatility following a merger suggests that post-merger integration risk concerns outweigh any diversification benefits in the immediate aftermath of a merger. Perhaps the strongest evidence against the principle of diversification following a merger can be obtained by looking at a sample of firms that diversified their industry operations by acquiring a firm outside their industry (inter-industry mergers).

A merger is classified as inter-industry if the acquirer and the target belong to differ-

ent industries according to the 48-industry classification of Fama and French (1997) and intra-industry otherwise. Table 8 and Figure 5 present the results for the three volatility measures grouped according to the type of merger: Intra or Inter-Industry. Surprisingly, we find from Figure 5 that the behavior of both intra- and inter-industry mergers are similar for all the volatility measures, even though we expected a greater decrease in these measures for inter-industry mergers as compared to intra-industry mergers. Contrary to the prediction of the portfolio theory, the figure shows that intra-industry mergers have a greater increase in volatility over time, i.e., volatilities start at lower levels compared to inter-industry mergers and end up at greater levels after the merger. Furthermore, the decrease in volatilities also is smaller, and they happen later than for intra-industry mergers. Table 8 reports the differences between the two groups' year-on-year changes for the three volatility measures. In all cases, the differences, as shown in the last two columns of the table, are either insignificant or of the opposite sign as predicted by the principle of diversification. Inter-industry mergers have similar increases in the run-up period as compared to intra-industry mergers. In the post-merger period, according to the principle of diversification, we would expect to find a greater decline in volatility for inter-industry mergers. To the contrary, we find that the decline in volatility is less (or insignificant) for inter-industry mergers as compared to intra-industry mergers.

Overall, the combined evidence lends considerable support for the view that post-merger integration risk is an important determinant of the volatility patterns observed after a merger.

3.2.4 Cross-Sectional Determinants of the Changes in Post-Merger Volatility

We now examine the determinants of the changes in volatility after a merger using a multiple regression framework. Specifically, we study the changes in our volatility measures between years 1-3 following the patterns identified in earlier sections. We include changes in market volatility (the VIX index) and the deal characteristics as explanatory variables. We do not include changes in firm-specific measures in the regression since it is not clear what

the direction of causality is between them and the volatility measures. The results of these regressions are presented in Table 9.

We report regression results for the change in all our three volatility measures between year 3 and year 1. We find that change in market volatility is an important determinant of change in total and systematic volatility. A 1% increase in the VIX index produces a 0.3% increase in total volatility and 1.42% increase in systematic volatility over the two-year period. Both the total and idiosyncratic volatility regressions have a positive and significant intercept, suggesting there is a lot of unexplained increase in volatility. Both measures are strongly and positively related to the number of acquisitions made by the firm. An increase in the number of acquisitions from the 25th to the 75th percentile increases both measures in year 3 by 0.5% over the year 1 levels. However, the number of acquisitions does not seem to affect systematic risks. This is consistent with the hypothesis that the increase in volatility during the period is due to integration risk, which is likely to be firm-specific and not systematic. The systematic risk is basically only significantly affected by the VIX.

Among deal characteristics we find that cash deals are associated with a decrease in the total and idiosyncratic volatility but with an increase in systematic volatility. Cash deals are often accompanied with an increase in leverage of the acquirer. Thus our result is consistent with the increase in leverage leading to an increase in systematic volatility. Cash deals are often used to acquire smaller targets and hence the resolution of integration risk occurs more quickly. This might explain the decrease in total and idiosyncratic volatility for cash deals. Finally, we find that inter-industry mergers are not different from intra-industry mergers in their total and idiosyncratic volatility changes, since the coefficient is largely insignificant. However, contrary to expectation, systematic volatility increases for inter-industry mergers (by about 1.7% with a significance level of 10%), and increases more for firms making greater numbers of acquisitions.

4 Implications of the Results

We now discuss the implications of our findings for the following effects well studied in the literature: the announcement wealth effect, the long-run underperformance of acquirers following a merger, and the diversification discount.

4.1 Acquirer Announcement Wealth Effect

A large literature over the last 25 years has examined the returns to acquirer shareholders on the announcement of an acquisition. Bruner (2004) summarizes the findings of these studies. There are 22 studies that report negative returns with 14 of the 22 being significantly negative. The significantly negative returns vary between 1% and 4%. There are 32 studies that report positive returns with 23 of them reporting significantly positive returns. Overall 26% of the studies show value destruction (significant negative returns); 31% show value conservation (insignificantly different from zero); and 43% show value creation (positively significant returns).

Moeller, Schlingemann and Stulz (2003) study the wealth effect of acquirers following an acquisition announcement and document an interesting size effect. They examine acquisitions by public firms from 1980 to 2001 and find that shareholders of small acquirers gain $8 billion from acquisitions while those of large acquirers lost $226 billion. Our evidence in Table 6 (Panel B) suggests that frequent acquirers are larger firms, with the market capitalization of the firm monotonically increasing across the quartiles of firms sorted by the number of deals undertaken during the sample period. These larger and frequent acquirers have a steady increase in their volatility and risk around the merger event (Figure 3). Thus, our results of significant increase in total and systematic measures of volatility around the merger event have implications for interpreting the differential wealth effect documented by Moeller et al. (2003). To the extent that mergers raise the risks of these larger and frequent acquirer firms that are priced by an asset pricing model, the expected returns on these firms

go up around the merger. This can result in an immediate drop in the stock price, consistent with their results. Our results can also help explain the massive wealth destruction effect from 1998-2001 documented by Moeller et al. (2004).

4.2 Long-run Underperformance Following Mergers

Loughran and Vijh (1997) show that acquirers earn an abnormal return of -6.5% over a five-year period following the merger when compared to a sample of matching firms. Cash-financed mergers have an abnormal return of +18.5%, while stock-financed mergers have an abnormal return of -24.2%. The matching of the firms is in the spirit of Fama and French (1992) in that it adjusts for size and book-to-market effects. Specifically, all firms are ranked according to their yearly required returns on equity (i.e., F=b0 + b1*Size + b2*Book-to-market). Firms are then ranked on this F-value and matched with the acquirer firms. Then the five-year buy-and-hold returns are computed for the acquirer and the control firm. However, to the extent that the acquirer volatility and risk change over the four-year period after the merger (increases for the first year and then decreases), the matching firm has to mimic the changes of the acquirer firm over the four years in order to draw inferences on long-run underperformance. For example, if the increase in volatility and risk (that is priced) of the acquirer over the first year is not taken into account while constructing the matching firm, the underperformance is understated. Similarly over the next three years, if the decrease in risk is not taken into account while constructing the matching firm, the underperformance is overstated. The net effect of this is a matter of empirical determination and has implications for the conclusion about long-run underperformance following mergers.

4.3 The Diversification Discount

A large literature following Berger and Ofek (1995) compares the market value of firms that operate multiple lines of business to the value of a portfolio of stand-alone firms operating in the same industries. They find that U.S. conglomerates are priced at a mean discount of 15%

(the diversification discount). The presence of such a discount is of considerable debate in the literature and has been challenged and attributed to selection bias by Graham, Lemmon, and Wolf (2002).

Since many firms become diversified by the process of M&A, it is of considerable interest to study the behavior of the discount over time around merger events. Using the same criteria applied by Berger and Ofek (1995) and other studies, we construct a sample of diversified firms each calendar year. We find that out of this sample about 30% of the firms undertook an M&A transaction in the **same** year as reported in Table 10. Given our results that changes in volatility around an M&A transaction for an acquirer are over a long period of several years, it is likely that almost the entire diversification discount sample would be consisting of acquirers experiencing changes in volatility and risk around mergers. Thus it would be of considerable interest to study the changes in diversification discount around a merger.

Table 10 and Figure 6 present the results of the changes in diversification discount over event time. We calculate the excess value measures following Berger and Ofek (1995) using asset multipliers in event time. We separate the firm into premium firms (excess value > 0) and discount firms (excess value < 0). From both Table 10 and Figure 6 it is clear that the excess value measures are steadily declining for the two-year period around the merger. The decrease is statistically indistinguishable from zero for discount firms and strongly significant for premium firms. At the same time, the cash flows from operations (scaled by total assets) is V-shaped in event time for both discount firms and premium firms. That is, there is a sharp rebound in actual cash flows following a merger. The difference between year +2 and year 0 cash flows is statistically significant at the 1% level for both the mean and the median. Recall that the value of any firm depends mechanically on the firm's future cash flows and future expected returns (discount rates). Combining an increase in actual cash flows following a merger (which is a good proxy for future cash flows) and a decline in the excess values, we argue that expected returns would have to increase for these firms. This is clearly

plausible given our findings of increase in risk and volatility measures following a merger. Thus our results suggest that changes in diversification discount of firms over time might be related to changes in risks of these firms over time (especially due to M&A transactions). Consistent with this story, Lamont and Polk (2001) show that diversified firms in general have higher expected returns than single-segment firms.

5 Conclusion

In this paper we study the changes in volatility and risk of acquirers around mergers and acquisitions and seek to understand the determinants of those changes. We find there is a strong run-up in volatility and risk beginning four years before the merger. This pre-merger run-up is consistent with the hypothesis that M&As are a response to industry shocks. We find that for a period of about one year after the merger the cross-sectional average of the volatility measures (total, systematic and idiosyncratic) continue to increase. Beyond one year the systematic volatility and beta begin to decline but idiosyncratic volatility does not. The post-merger volatility pattern is consistent with the notion that the risk of integration of the acquirer and the target firms gets resolved over time. Interestingly, there is no difference between the volatility patterns of intra- and inter-industry mergers.

Our findings have important implications for understanding several issues, including the announcement wealth effect of mergers, the long-run underperformance of acquirers in M&A transactions and changes in the diversification discount over time. An interesting avenue for future research is to examine if managers systematically underestimate the integration risk of M&A transactions. If this is the case, the value loss of the acquirer on the announcement of a merger can be explained in part by integration risk considerations, to the extent that integration risk is priced by the markets.

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Table 1: Number of Mergers, Mode of Deal, and Form of Payment

This table reports the number of mergers, mode of deal, and form of payment over the sample period by COMPUSTAT calendar year and quarter. Deal Value is in billions of dollars. All other values are as percentage of the number of deals in each quarter. Cash and Stock represent deals that are 100% financed by cash and stock respectively. Inter Ind. is a merger where the acquirer and the target belong to different industries. Industry classification follows the 48-industry groupings by Fama and French (1997). The sample consists of all deals reported in SDC Platinum database and for which implied volatility of at-the-money call options (30-day maturity) is available for the acquirer in the Option Metrics database. The sample period is from 1995.Q4 to 2002.Q3.

Year	Qtr	No.	Deal Value	Tender Offer	Friendly	Cash	Stock	Inter Ind.
1995	4	90	16.2	3.33	100.00	28.89	14.44	37.78
1996	1	218	40.4	3.67	97.71	32.11	12.39	39.45
1996	2	211	19.2	1.90	97.63	28.91	13.74	45.50
1996	3	256	36.6	1.56	94.14	28.13	16.41	39.84
1996	4	224	52.2	4.46	96.88	29.91	13.39	37.50
1997	1	253	28.5	2.37	98.42	25.69	13.04	43.08
1997	2	264	29.9	2.65	98.11	31.82	11.36	37.12
1997	3	262	39.5	1.91	99.62	30.92	16.41	44.66
1997	4	322	54.0	4.04	98.45	33.85	10.87	42.24
1998	1	287	48.2	3.14	98.95	26.83	19.16	40.77
1998	2	368	191.9	2.45	96.74	26.63	12.23	41.85
1998	3	380	79.0	2.37	97.11	28.95	13.42	42.37
1998	4	319	89.0	3.13	97.81	30.72	13.48	38.24
1999	1	377	136.9	2.92	97.88	33.16	11.41	43.24
1999	2	427	177.7	4.22	99.30	34.19	17.80	43.79
1999	3	388	158.6	3.09	97.94	24.74	20.10	40.98
1999	4	425	192.3	2.59	97.18	30.12	20.71	44.94
2000	1	421	176.9	2.61	97.15	27.79	21.62	44.42
2000	2	388	216.1	4.38	98.45	27.58	19.33	47.94
2000	3	356	111.1	5.06	98.60	32.30	18.82	46.63
2000	4	283	76.4	2.83	98.59	32.16	13.07	50.18
2001	1	274	51.8	2.19	98.91	33.21	10.58	44.53
2001	2	279	144.4	3.94	98.21	34.05	14.34	42.65
2001	3	234	63.8	4.70	98.29	29.06	6.41	42.31
2001	4	221	41.0	2.71	98.64	30.77	10.41	43.89
2002	1	202	30.6	3.96	98.02	35.64	7.43	43.56
2002	2	216	26.1	4.17	98.61	41.67	4.17	41.67
2002	3	194	7.3	1.03	100.00	36.08	3.61	50.00
All Qtrs		8139	2335.5	3.15	98.03	30.68	14.36	43.11

Table 2: Volatilities and Beta Summary Statistics

This table provides the summary statistics of implied volatility of at-the-money call options (30-day maturity), beta, systematic volatility and idiosyncratic volatility for acquirer by event time measured in quarters relative to the merger announcement date. Beta is computed using daily return data within each quarter. Systematic volatility is computed by multiplying beta and the average VIX index for each quarter. The VIX index data are obtained from the CBOE. Idiosyncratic volatility is computed as the square root of the difference between the total variance and the systematic variance. The sample period is from 1995.Q4 to 2002.Q3.

Panel A: Acquirer Implied Volatility in %

					Quantiles			
Event time	n	Mean	S.D.	Max	Q3	Mdn	Q1	Min
-16	1987	47.49	19.10	169.03	59.21	43.08	32.74	11.27
-12	3088	50.70	21.82	328.38	62.55	45.93	34.82	14.54
-8	4225	54.31	23.37	243.77	67.51	48.63	37.08	13.15
-4	5476	57.22	24.66	336.82	69.86	51.29	39.38	4.35
-1	6642	59.40	25.58	342.41	73.44	53.13	40.80	4.34
1	6765	61.13	26.66	266.57	75.86	54.77	41.52	3.89
4	6404	62.90	26.67	445.57	78.70	57.26	42.68	3.74
8	5412	62.61	24.16	195.46	77.17	58.12	44.08	3.23
12	4050	62.04	22.89	209.77	75.65	58.07	44.48	9.28
16	2720	61.37	22.31	224.14	74.09	57.25	44.36	5.64

Panel B: Acquirer Beta

					Quantiles			
Event time	n	Mean	S.D.	Max	Q3	Mdn	Q1	Min
-16	1987	1.02	0.86	6.26	1.39	0.93	0.53	-4.91
-12	3088	1.04	0.91	7.68	1.41	0.89	0.51	-2.19
-8	4225	1.07	0.94	8.42	1.49	0.90	0.49	-4.51
-4	5476	1.13	1.01	6.67	1.58	0.95	0.50	-3.61
-1	6642	1.18	1.03	7.26	1.63	0.97	0.53	-2.52
1	6765	1.23	1.06	8.42	1.71	1.02	0.54	-2.15
4	6404	1.24	1.11	9.12	1.76	1.03	0.54	-3.28
8	5412	1.16	1.02	9.80	1.63	0.99	0.51	-3.00
12	4050	1.08	1.01	7.18	1.55	0.90	0.44	-2.44
16	2720	1.06	0.96	9.66	1.51	0.88	0.43	-2.02

Table 2 (continued): Implied Volatility Summary Statistics

Panel C - Acquirer Systematic Volatility in %

					Quantiles			
Event time	n	Mean	S.D.	Max	Q3	Mdn	Q1	Min
-16	1987	23.18	17.88	139.54	30.66	18.62	10.68	0.05
-12	3088	24.22	19.98	150.08	31.97	18.83	10.84	0.00
-8	4225	25.95	21.54	219.50	34.70	20.63	10.86	0.03
-4	5476	28.50	23.99	174.90	37.66	22.25	11.59	0.02
-1	6642	29.61	24.07	206.08	39.87	23.09	12.53	0.01
1	6765	30.99	25.37	194.52	41.49	24.44	12.89	0.02
4	6404	32.25	26.55	222.58	43.39	24.99	13.41	0.01
8	5412	30.94	24.80	302.34	42.23	24.55	13.24	0.02
12	4050	29.17	24.65	213.14	39.51	22.29	11.63	0.02
16	2720	28.34	24.00	297.25	38.79	22.06	11.39	0.01

Panel D: Acquirer Idiosyncratic Volatility in %

					Quantiles			
Event time	n	Mean	S.D.	Max	Q3	Mdn	Q1	Min
-16	1820	40.82	19.37	163.07	51.43	37.52	26.34	1.89
-12	2845	43.64	21.91	327.76	55.15	39.34	28.42	0.84
-8	3876	46.86	23.14	241.02	59.47	42.21	30.30	3.11
-4	5032	48.49	23.21	336.12	60.43	44.13	32.57	0.66
-1	6164	50.13	23.88	341.40	62.69	45.51	33.43	1.17
1	6247	51.40	24.84	266.23	64.53	46.59	33.98	1.19
4	5854	53.01	24.75	445.23	66.84	48.56	35.52	2.09
8	4955	53.37	23.73	195.46	67.00	49.71	36.05	2.12
12	3708	53.72	22.83	203.26	66.95	50.09	37.61	2.72
16	2497	53.40	22.44	224.11	65.86	50.14	38.07	1.66

Table 3: Changes in Volatilities and Beta

This table provides the univariate tests of changes in implied volatility of at-the-money call options (30-day maturity), beta, systematic volatility and idiosyncratic volatility for acquirer each year measured relative to the merger announcement date. Mean and Median for the period (i,j) denotes the change in each measure between year j and year i, where i and j are measured relative to the merger announcement date. The t-Test (Wilcoxon test) statistic tests the hypothesis that Mean (Median) each year is zero. Beta is computed using daily return data within each quarter. Systematic volatility is computed by multiplying beta and the average VIX index for each quarter. The VIX index data are obtained from the CBOE. Idiosyncratic volatility is computed as the square root of the difference between the total variance and the systematic variance. The sample period is from 1995.Q4 - 2002.Q3. ***,**,* indicates significance at 1%, 5% and 10% level respectively.

	Mean	t-test	Median	Wilcoxon	Mean	t-test	Median	Wilcoxon
Period	Panel A : Total Volatility				Panel B : Systematic Volatility			
(-4,-3)	3.21	5.36***	2.85	4.86***	1.05	1.90*	0.21	0.72
(-3,-2)	3.61	6.72***	2.70	6.39***	1.72	3.48***	1.80	3.15***
(-2,-1)	2.91	5.90***	2.66	6.20***	2.55	5.42***	1.62	4.32***
(-0.25,+0.25)	1.73	3.83***	1.64	3.52***	1.38	3.22***	1.35	2.80***
(+0.25,1)	1.77	3.81***	2.49	4.49***	1.26	2.79***	0.55	2.28**
(1,2)	-0.29	-0.62	0.86	1.45	-1.31	-2.75***	-0.44	-1.67*
(2,3)	-0.57	-1.16	-0.05	-0.29	-1.77	-3.45***	-2.26	-4.51***
(3,4)	-0.67	-1.19	-0.82	-1.07	-0.83	-1.38	-0.23	-1.17
	Panel C : Beta				Panel D: Idiosyncratic Volatility			
(-4,-3)	0.02	0.68	-0.04	-0.93	2.82	4.48***	1.82	4.12***
(-3,-2)	0.03	1.54	0.01	1.54	3.22	5.76***	2.87	5.57***
(-2,-1)	0.07	3.22***	0.05	2.14***	1.63	3.3***	1.92	4.12***
(-0.25,+0.25)	0.05	2.66***	0.05	2.36***	1.27	2.9***	1.08	2.61***
(+0.25,1)	0.02	0.90	0.01	0.46	1.61	3.56***	1.97	4.51***
(1,2)	-0.08	-4.07***	-0.04	-2.97***	0.36	0.77	1.15	1.49
(2,3)	-0.08	-3.83***	-0.09	-4.66***	0.35	0.69	0.38	1.37
(3,4)	-0.02	-0.74	-0.02	-0.48	-0.32	-0.55	0.05	0.38

Table 4: Portfolio Analysis of Acquirer and Target

This table provides the portfolio implied volatility of at-the-money call options (30-day maturity), systematic volatility and idiosyncratic volatility for each merger deal measured relative to the merger announcement date. The portfolio is the market value weighted combination of acquirer and target before the merger and the combined entity (acquirer) after the merger. Portfolio volatility before the merger is obtained using the portfolio variance formula on the acquirer and the target. Portfolio volatility after the merger is the volatility of the combined entity (acquirer). Correlation between the acquirer and the target each quarter is computed using daily return data within the quarter. Beta is computed using daily return data within each quarter. Beta before the merger is the market value weighted average of the acquirer and the target. Beta after the merger is the beta of the combined entity (acquirer). Systematic volatility is computed by multiplying the portfolio beta and the average VIX index for each quarter. The VIX index data are obtained from the CBOE. Idiosyncratic volatility is computed as the square root of the difference between the total variance and the systematic variance. The sample period is from 1995.Q4 - 2002.Q3.

	Total Volatility			Systematic Volatility		Idiosyncratic Volatility		
Quarter	N	Mean	Median	Mean	Median	N	Mean	Median
-16	45	38.57	37.37	22.32	17.71	39	31.87	31.17
-12	60	41.26	36.41	29.53	27.32	46	31.21	26.77
-8	80	47.74	43.29	30.70	28.42	68	36.88	35.31
-4	119	54.25	48.57	27.37	21.39	111	45.44	44.09
-1	128	56.58	50.29	31.21	25.59	121	43.34	41.07
1	144	59.58	52.67	32.87	26.51	128	49.22	45.44
4	113	54.89	48.39	31.59	24.65	102	43.70	41.76
8	65	55.88	48.61	36.78	34.68	52	43.96	37.96
12	27	49.23	42.94	26.09	22.77	25	40.76	36.40
16	15	48.76	43.03	32.82	25.49	13	34.61	31.83

Table 5: Industry Shocks of Acquiring Firms

This table provides the analysis of industry shocks of acquiring firms around the merger event by event time measured in years relative to the merger announcement date. Industry Shock is defined as the shock to sales and is computed following the method in Mitchell and Mulherin (1996). The cross sectional average of this measure (in percent) and its distribution is presented in Panel A. Panel B provides the regression analysis of the change in volatility (total, systematic and idiosyncratic) between year -3 and year -1 for the same firm before the merger announcement date. ΔVIX is the change in the VIX index for the corresponding period before the merger. Industry classification follows the 48-industry groupings by Fama and French (1997). The sample period is from 1995.Q4 - 2002.Q3. ***,**,* indicates significance at 1%, 5% and 10% level respectively.

Panel A: Summary Statistics of Industry Shocks

Event time	n	Mean	S.D.
-4	8731	5.56	4.58
-3	8731	5.90	4.96
-2	8731	6.24	5.60
-1	8731	6.45	6.06
0	8731	6.73	6.40
1	7853	6.66	6.41
2	6750	6.79	6.77
3	5130	7.00	7.35
4	3460	6.81	6.83

Panel B : Regression Analysis

	ΔTotalvol	ΔSysvol	ΔIdiovol
	(1)	(2)	(3)
Const.	5.59***	0.17	4.21***
	(0.37)	(0.48)	(0.45)
ΔVIX	0.11**	1.14***	
	(0.05)	(0.06)	
ΔIndShock	0.26***	-0.11*	0.28***
	(0.05)	(0.06)	(0.06)
Obs.	2998	2998	2557
R^2(%)	1.09	10.25	0.80

Table 6: Summary Information on Deal Activity and Firm Characteristics of Acquirers

This table provides the distribution of number of merger deals and days between deals for acquirers in the sample (Panel A). It also provides the mean and median firm characteristics one year before the merger date sorted into quartiles (Panel B). Acquiring firms are grouped into quartiles based on the total number of mergers undertaken within the sample period. Quartile 1 consists of firms with the least number of mergers and Quartile 4 the most. Inter Ind. is a dummy variable that assumes the value 1 for a merger where the acquirer and the target belong to different industries. Industry classification follows the 48-industry groupings by Fama and French (1997). Firm Characteristics are obtained from COMPUSTAT Quarterly data files. Market Cap is the product of price and number of shares outstanding (Data14*Data61). Q Ratio is the ratio of market value of assets to book value of assets ((Data44-Data60+Data14*Data61)/Data44). R and D to Sales is the ratio of R and D expenses to sales (Data4/Data2). Tangibility is the ratio of property, plant and equipment to total assets (Data42/Data44). Profitability is the ratio of operating income before depreciation to total assets (Data21/Data44); Leverage is the ratio of long-term debt to total assets (Data51/Data44). The t-Test (Wilcoxon test) statistic tests the hypothesis that Mean (Median) of the difference between quartile 4 and quartile 1 is zero (Panel C). The sample period is from 1995.Q4 - 2002.Q3. ***,**,* indicates significance at 1%, 5% and 10% level respectively.

Panel A: Summary Statistics of Deal Activity

Variable	Obs	Mean	Median	Std Dev	Min	25th	75th	Max
No. of deals	1705	4.82	3	5.65	1	1	6	68
Days b/w deals	6514	225.32	116	293.02	1	41	289	2314

Panel B: Characteristics of Acquirers Sorted by Deal Activity Quartiles

	Quartile 1		Quartile 2		Quartile 3		Quartile 4	
Variable	Mean	Median	Mean	Median	Mean	Median	Mean	Median
Diversify	43.4%	0	40.4%	0	44.1%	0	43.2%	0
Market Cap	2690.27	527.79	2614.77	632.65	4015.04	829.21	14221.63	1952.85
Q Ratio	3.84	2.26	3.72	2.20	2.90	2.00	3.17	2.18
Tangibility	26.5%	19.5%	26.8%	19.4%	27.7%	20.7%	24.1%	18.3%
R and D to Sales	84.6%	15.4%	145.7%	12.3%	99.9%	9.7%	17.6%	9.1%
Profitability	-0.3%	3.4%	1.8%	3.6%	3.1%	4.0%	4.5%	4.3%
Leverage	14.8%	5.4%	16.0%	8.7%	18.3%	11.2%	20.1%	15.2%

Panel C: Difference Tests

Variable	t-test (Q4-Q1)	Wilcoxon (Q4-Q1)
Diversify	-0.08	-0.08
Market Cap	4.92^{***}	11.33^{***}
Q Ratio	-2.89^{***}	-1.33
Tangibility	-2.13^{**}	-0.73
R and D to Sales	-8.12^{***}	-6.78^{***}
Profitability	4.67^{***}	5.46^{***}
Leverage	4.09^{***}	6.25^{***}

Table 7: Summary Information on Relative Size of Acquirer and Target

This table provides the distribution of the relative size of the acquirer and the target. Firms are first sorted into two groups, below and above the median number of acquisitions in the sample period (infrequent and frequent acquirers respectively). Firms are further sorted into two groups below and above the median relative size of the target to the acquirer (relative size small and relative size large respectively). Relative size is defined as the ratio of the average market capitalization of the target to the sum of the average market capitalizations of the target and acquirer. The average is computed over the calender year preceding the merger year. Total volatility is measured using the implied volatility of at-the-money call options (30-day maturity). Panel A provides the distribution of the relative size in the four groups described above. Panel B provides the differences in mean total volatility between quarter 1 and quarter 8 after the merger for infrequent and frequent acquirers respectively. The t-test statistic tests the hypothesis that difference of the mean total volatility is zero. The sample period is from 1995.Q4 - 2002.Q3. ***,**,* indicates significance at 1%, 5% and 10% level respectively.

Panel A: Relative Size and Count Summary Statistics

No. of Acq	Rel - Size	Variable	Obs	Mean	Median	Std Dev	Min	25th	75th	Max
Infrequent	Small	Relsize	40	3.0%	3.3%	2.0%	0.05%	0.8%	4.5%	6.7%
		Count	40	1.7	2	0.5	1	1	2	2
Infrequent	Large	Relsize	70	28.6%	22.5%	19.8%	7.2%	12.8%	36.5%	82.3%
		Count	70	1.6	2	0.5	1	1	2	2
Frequent	Small	Relsize	464	2.2%	1.5%	2.1%	0.01%	0.4%	3.6%	7.0%
		Count	464	17.4	13	16.4	3	7	20	68
Frequent	Large	Relsize	388	25.2%	20.7%	17.3%	7.1%	12.3%	32.0%	96.4%
		Count	388	9.2	7	7.2	3	4	11	68

Panel B: Difference in Mean Total Volatility between Quarter 1 and Quarter 8

No. of Acq	Rel - Size	Mean	t-stat
Infrequent	Small	-14.1	-2.84***
Infrequent	Large	-5.5	-1.42
Frequent	Small	-0.4	-0.33
Frequent	Large	4.6	2.92***

Table 8: Changes in Volatilities by Intra/Inter Industry Mergers

This table provides the univariate tests of differences of changes in implied volatility of at-the-money call options (30-day maturity), systematic volatility and idiosyncratic volatility between intra-industry acquirers and inter-industry acquirers for each year measured relative to the merger announcement date. Inter Industry is a merger where the acquirer and the target belong to different industries. Industry classification follows the 48-industry groupings by Fama and French (1997). Mean and Median for the period (i,j) denotes the change in each measure between year j and year i, where i and j are measured relative to the merger announcement date. The t-Test (Wilcoxon test) statistic tests the hypothesis that Mean (Median) difference of the change in volatility between intra- and inter-industry mergers each year is zero. Beta is computed using daily return data within each quarter. Systematic volatility is computed by multiplying beta and the average VIX index for each quarter. The VIX index data are obtained from the CBOE. Idiosyncratic volatility is computed as the square root of the difference between the total variance and the systematic variance. The sample period is from 1995.Q4 - 2002.Q3. ***,**,* indicates significance at 1%, 5% and 10% level respectively.

Panel A: Acquirer Implied Volatility Change in %

	Intra Industry				Inter Industry				Intra-Inter	
Period	N	Mean	Std.Dev	Median	N	Mean	Std.Dev	Median	t-test	Wilcoxon
(-4,-3)	1023	3.29	16.53	2.62	962	2.48	13.15	2.27	1.19	1.23
(-3,-2)	1625	2.83	16.74	2.58	1428	3.49	14.82	3.56	-1.15	-2.28
(-2,-1)	2245	1.82	18.51	1.73	1918	1.82	16.17	2.62	0.02	-1.30
(1,2)	2820	1.63	20.10	2.32	2187	1.09	20.93	1.73	0.93	0.85
(2,3)	2206	0.52	20.61	0.81	1628	1.58	20.63	2.18	-1.57	-1.88
(3,4)	1475	-1.73	19.48	-1.99	1087	-0.05	21.41	-0.05	-2.07	-2.35

Panel B: Acquirer Systematic Volatility Change in %

	Intra Industry				Inter Industry				Intra-Inter	
Period	N	Mean	Std.Dev	Median	N	Mean	Std.Dev	Median	t-test	Wilcoxon
(-4,-3)	1023	2.47	24.00	2.20	962	3.43	22.17	2.37	-0.92	-0.46
(-3,-2)	1625	2.67	23.83	2.38	1428	2.49	23.23	2.96	0.21	-0.37
(-2,-1)	2245	2.64	24.61	2.21	1918	2.28	24.27	1.31	0.48	0.99
(1,2)	2820	0.90	25.88	0.93	2187	1.97	27.10	2.06	-1.42	-1.63
(2,3)	2206	1.72	26.38	1.19	1628	1.40	25.04	1.34	0.38	0.23
(3,4)	1475	2.76	23.66	2.19	1087	3.49	25.32	2.63	-0.75	-0.95

Panel C: Acquirer Idiosyncratic Volatility Change in %

	Intra Industry				Inter Industry				Intra-Inter	
Period	N	Mean	Std.Dev	Median	N	Mean	Std.Dev	Median	t-test	Wilcoxon
(-4,-3)	864	2.70	22.18	1.62	757	1.88	17.79	1.22	0.82	0.64
(-3,-2)	1399	1.93	21.25	1.07	1129	2.95	19.50	2.67	-1.24	-1.89
(-2,-1)	1921	0.87	23.32	0.62	1565	0.59	19.97	1.32	0.37	-0.63
(1,2)	2444	1.52	22.95	1.44	1821	0.84	22.91	0.51	0.95	0.96
(2,3)	1938	0.71	23.26	-0.05	1387	0.81	24.28	0.66	-0.13	-0.74
(3,4)	1312	-2.98	21.82	-3.37	953	-1.47	23.64	-2.04	-1.58	-1.70

Table 9: Regression Analysis of Change in Acquirer Volatility after Merger

The table reports the regression results of the change in volatility (total, systematic and idiosyncratic) between year 3 and year 1 for the same firm after the merger announcement date. ΔVIX is the change in the VIX index for the corresponding period after the merger. Cash is a dummy variable that assumes the value 1 for deals that are 100% financed by cash and 0 otherwise. Tender offer is a dummy variable that assumes the value 1 for deals that are tender offers and 0 otherwise. Friendly is a dummy variable that assumes the value 1 for deals that are coded as friendly in the SDC database and 0 otherwise. No. Acquisitions is the total number of acquisitions made by the firm over the sample period. Inter Ind. is a dummy variable that assumes the value 1 for a merger where the acquirer and the target belong to different industries. Industry classification follows the 48-industry groupings by Fama and French (1997). The sample period is from 1995.Q4 - 2002.Q3. ***,**,* indicates significance at 1%, 5% and 10% level respectively.

	ΔTotalvol	ΔTotalvol	ΔSysvol	ΔSysvol	ΔIdiovol	ΔIdiovol
	(1)	(2)	(3)	(4)	(5)	(6)
Const.	6.27**	6.47**	-0.14	0.49	8.53**	8.25**
	(2.71)	(2.72)	(2.86)	(2.90)	(3.69)	(3.72)
ΔVIX	0.31***	0.31***	1.42***	1.42***		
	(0.06)	(0.06)	(0.07)	(0.07)		
Cash	-1.44*	-1.45*	1.82*	1.79*	-1.86*	-1.84*
	(0.79)	(0.79)	(0.96)	(0.96)	(1.04)	(1.04)
Tender Offer	2.32	2.31	-0.97	-0.99	2.04	2.05
	(1.53)	(1.53)	(2.23)	(2.23)	(2.23)	(2.23)
Friendly	-3.04	-3.03	-0.03	0.01	-5.08	-5.07
	(2.65)	(2.65)	(2.69)	(2.70)	(3.60)	(3.60)
No. Acquisitions	0.10***	0.09***	0.04	0.01	0.10***	0.12**
	(.02)	(.03)	(0.03)	(0.04)	(0.03)	(0.05)
Inter-Industry	1.01	0.60	1.70*	0.39	-0.21	0.34
	(0.74)	(1.01)	(0.88)	(1.21)	(0.96)	(1.33)
Inter-Ind.*No.Acq.		0.03		0.10*		-0.03
		(0.04)		(0.05)		(0.07)
Obs.	3586	3586	3586	3586	3011	3011
R^2	0.01	0.01	0.10	0.10	0.004	0.004

Table 10: Diversification Discount, Cash Flow and Volatility Patterns Around Mergers

This table shows the number of firms used in the diversification discount studies that have a merger transaction in the same year. This table also shows the behavior of the the mean diversification discount (premium), the mean ratio of cashflow to total assets of acquiring firms, and the mean systematic volatility around the merger event by event time measured in years relative to the merger announcement date. Diversification discount (premium) is computed as the excess value measure based on asset multipliers following Berger and Ofek (1995). Cashflow is defined as the cash flow from operations taken from COMPUSTAT's statement of cashflows (annual COMPUSTAT data item 308 minus annual COMPUSTAT data item 124). Total assets is measured as the book value of total assets (DATA6) minus the book value of equity (DATA60) plus the market value of equity. Market value of equity is obtained from CRSP database as the product of shares outstanding and the closing stock price. The t-test (Wilcoxon) statistic tests the hypothesis that difference between the means (median) in years 0 and 2 is zero. ***,**,* indicates significance at 1%, 5% and 10% level respectively. The sample period is from 1990 to 2002.

Year	Total Firms	Merger Firms	%	Year	Total Firms	Merger Firms	%
1996	1353	361	26.7%	2000	4536	1297	28.6%
1997	1479	429	29.0%	2001	4014	988	24.6%
1998	4229	1277	30.2%	2002	2168	593	27.4%
1999	4576	1378	30.1%	Overall	11637	3445	29.6%

	t	-2	-1	0	1	2	Difference (0,+2)	
Discount Firms							t-stat	Wilcoxon
Discount								
	Mean	-0.360	-0.389	-0.385	-0.399	-0.399	-1.25	
	Median	-0.271	-0.287	-0.291	-0.318	-0.315		-1.69*
	N	800	1194	1971	2149	1963		
Cash Flow								
	Mean	6.06	5.06	2.50	3.15	4.54	4.68***	
	Median	5.85	5.50	4.34	4.85	5.50		6.19***
	N	876	1402	2532	2715	2579		
Premium Firms								
Premium								
	Mean	0.555	0.599	0.539	0.517	0.502	-2.60***	
	Median	0.355	0.440	0.393	0.384	0.367		-2.90***
	N	972	1806	2433	2320	2088		
Cash Flow								
	Mean	3.53	3.43	3.22	2.92	4.17	4.46***	
	Median	4.24	3.92	3.92	4.00	4.53		5.51***
	N	967	1800	2425	2311	2082		

Figure 1: Volatility of Acquiring Firms Around the Merger Event

This figure shows the behavior of the average total volatility, beta, systematic volatility and idiosyncratic volatility of acquiring firms around the merger event by event time measured in quarters relative to the merger announcement date. Total volatility is measured using the implied volatility of at-the-money call options (30-day maturity). Beta is computed using daily return data within each quarter. Systematic volatility is computed by multiplying beta and the average VIX index for each quarter. The VIX index data are obtained from the CBOE. Idiosyncratic volatility is computed as the square root of the difference between the total variance and the systematic variance. We also graph the median of total volatility from a matched sample with no merger activity in the total volatility figure, and the median of the VIX index in the systematic volatility figure. Time period 0 is simply the average value of observations right before and after the merger event and provided only as a visual aid. The sample period is from 1995.Q4 to 2002.Q3.

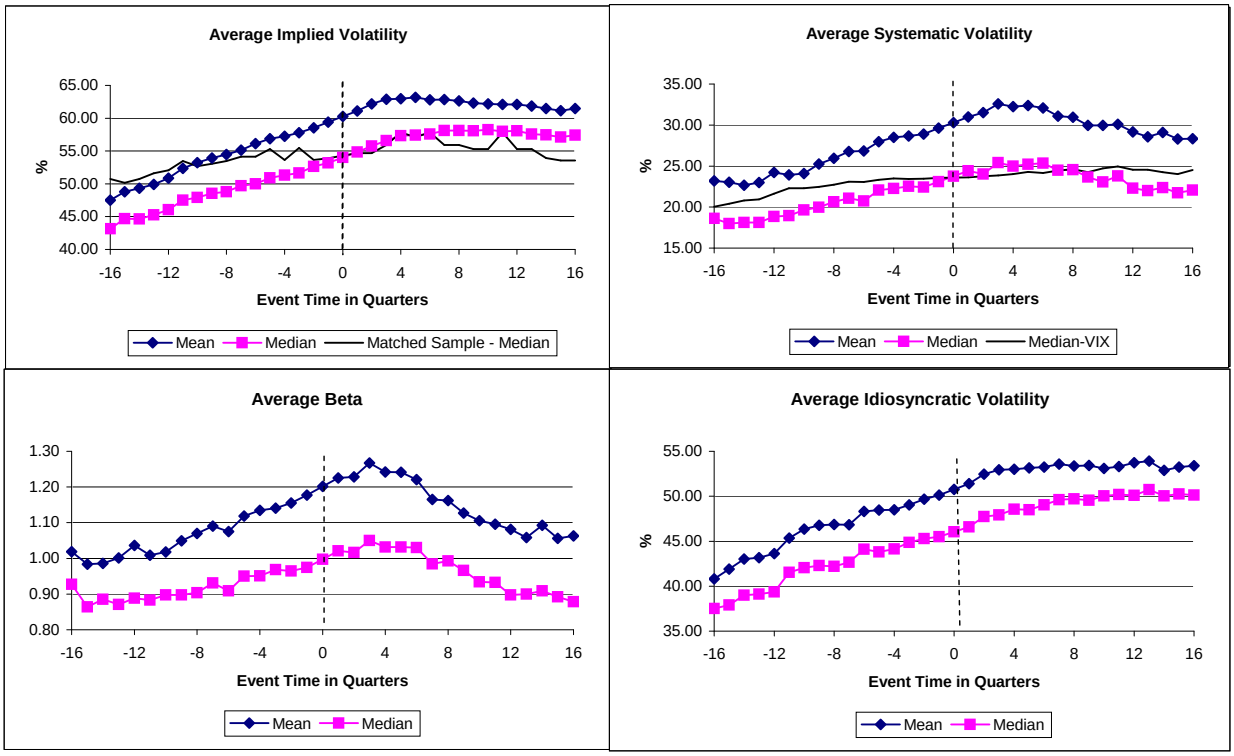

Figure 2: Industry Shocks of Acquiring Firms

This figure shows the behavior of industry shocks of acquiring firms around the merger event by event time measured in years relative to the merger announcement date. Industry Shock is defined as the shock to sales and is computed following the method in Mitchell and Mulherin (1996). The cross sectional average of this measure is presented. The sample period is from 1995.Q4 to 2002.Q3.

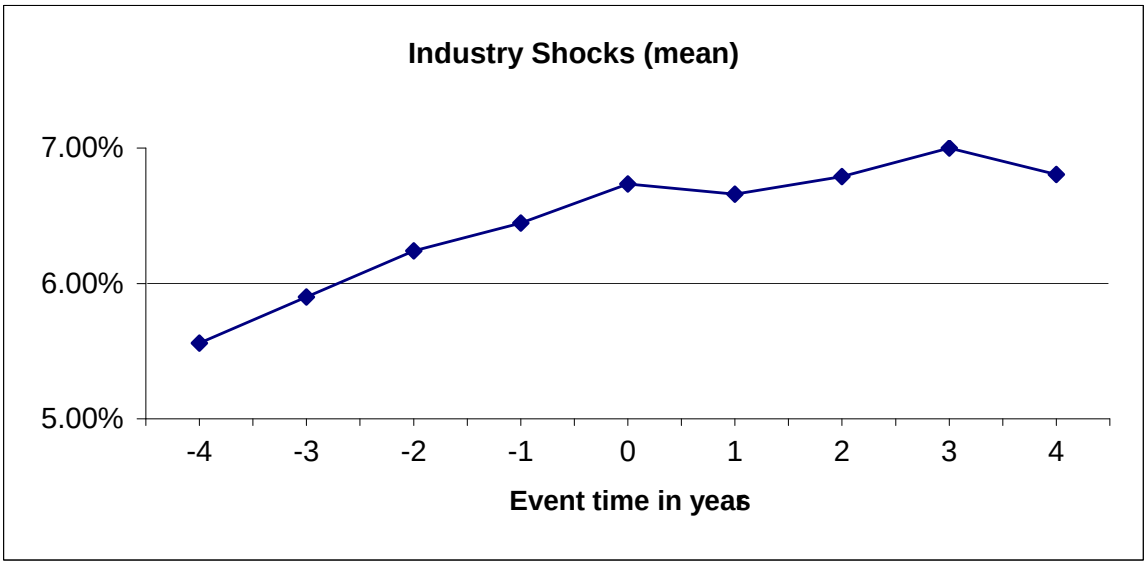

Figure 3: Volatility of Acquiring Firms Grouped by Merger Activity Levels

This figure shows the behavior of the average total volatility, systematic volatility and idiosyncratic volatility of acquiring firms around the merger event by event time measured in quarters relative to the merger announcement date. Firms are grouped in quartiles based on the number of acquisitions made in the sample period. Q1 is the set of firms with the least number of acquisitions and Q4 the most. Total volatility is measured using the implied volatility of at-the-money call options (30-day maturity). Beta is computed using daily return data within each quarter. Systematic volatility is computed by multiplying beta and the average VIX index for each quarter. The VIX index data are obtained from the CBOE. Idiosyncratic volatility is computed as the square root of the difference between the total variance and the systematic variance. Time period 0 value is simply the average value of observations right before and after the merger event and provided only as a visual aid. The sample period is from 1995.Q4 to 2002.Q3.

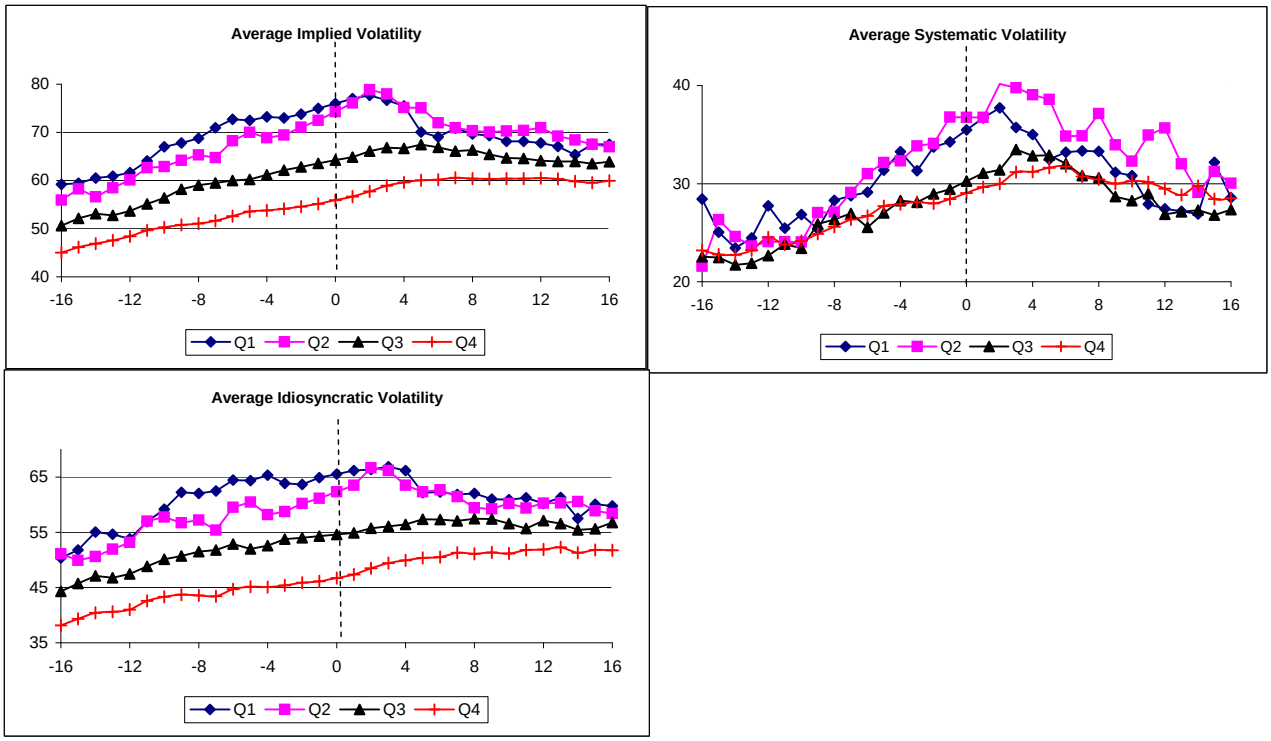

Figure 4: Volatility of Acquiring Firms Grouped by Merger Activity Levels and Relative Size
This figure shows the behavior of the average total volatility of acquiring firms around the merger event by event time measured in quarters relative to the merger announcement date. Firms are sorted into two groups based on the relative size of the target to the acquirer. Relative size is defined as the ratio of the average market capitalization of the target to the sum of the average market capitalizations of the target and acquirer. The average is computed over the calender year preceding the merger year. The top panel consists of acquirers with the number of acquisitions made in the sample period below the median number of acquisitions for all acquirers. The bottom panel consists of acquirers with the number of acquisitions made in the sample period above the median number of acquisitions for all acquirers. Total volatility is measured using the implied volatility of at-the-money call options (30-day maturity). Time period 0 value is simply the average value of observations right before and after the merger event and provided only as a visual aid. The sample period is from 1995.Q4 to 2002.Q3.

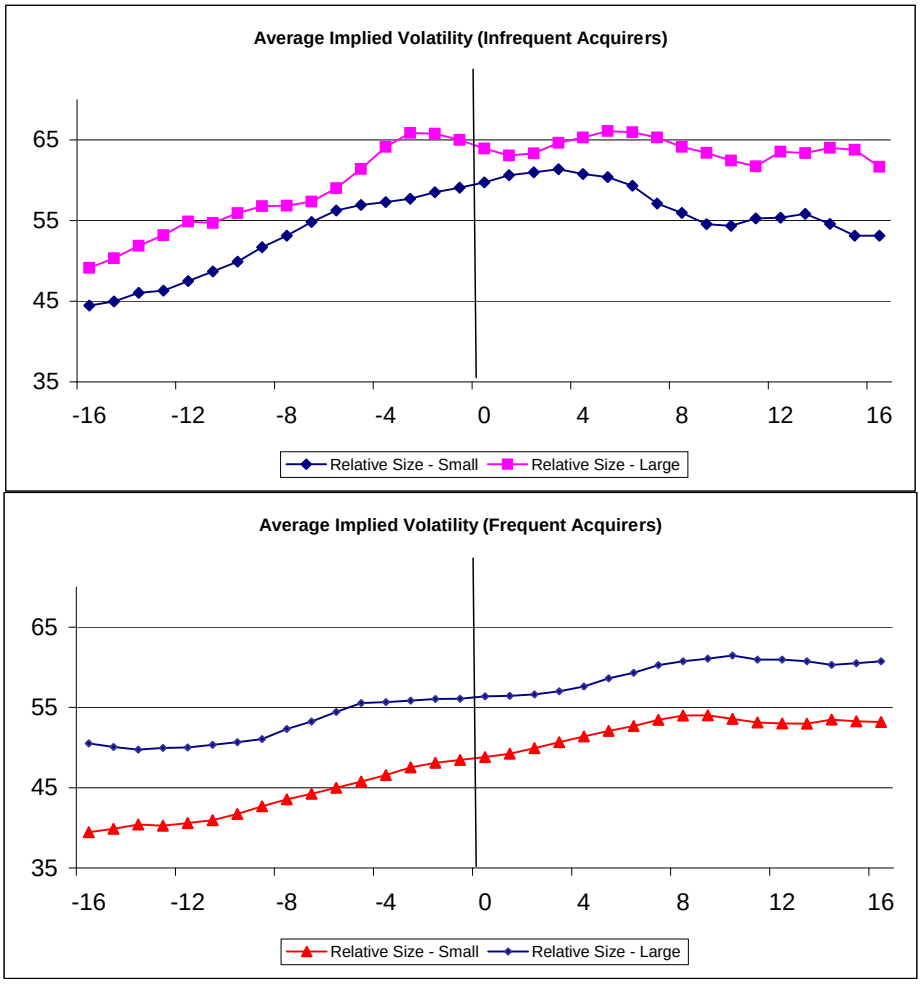

Figure 5: Volatility of Intra/Inter Industry Mergers

This figure shows the behavior of the average total volatility, beta, systematic volatility and idiosyncratic volatility of acquiring firms around the merger event by event time measured in quarters relative to the merger announcement date. Inter industry merger is a merger where the acquirer and target belong to different industries. Intra industry merger is a merger where the acquirer and target belong to the same industry. Industry classification follows the 48 industry groupings by Fama and French (1997). Total volatility is measured using the implied volatility of at-the-money call options (30-day maturity). Beta is computed using daily return data within each quarter. Systematic volatility is computed by multiplying beta and the average VIX index for each quarter. The VIX index data are obtained from the CBOE. Idiosyncratic volatility is computed as the square root of the difference between the total variance and the systematic variance. Time period 0 value is simply the average value of observations right before and after the merger event and provided only as a visual aid. The sample period is from 1995.Q4 to 2002.Q3.

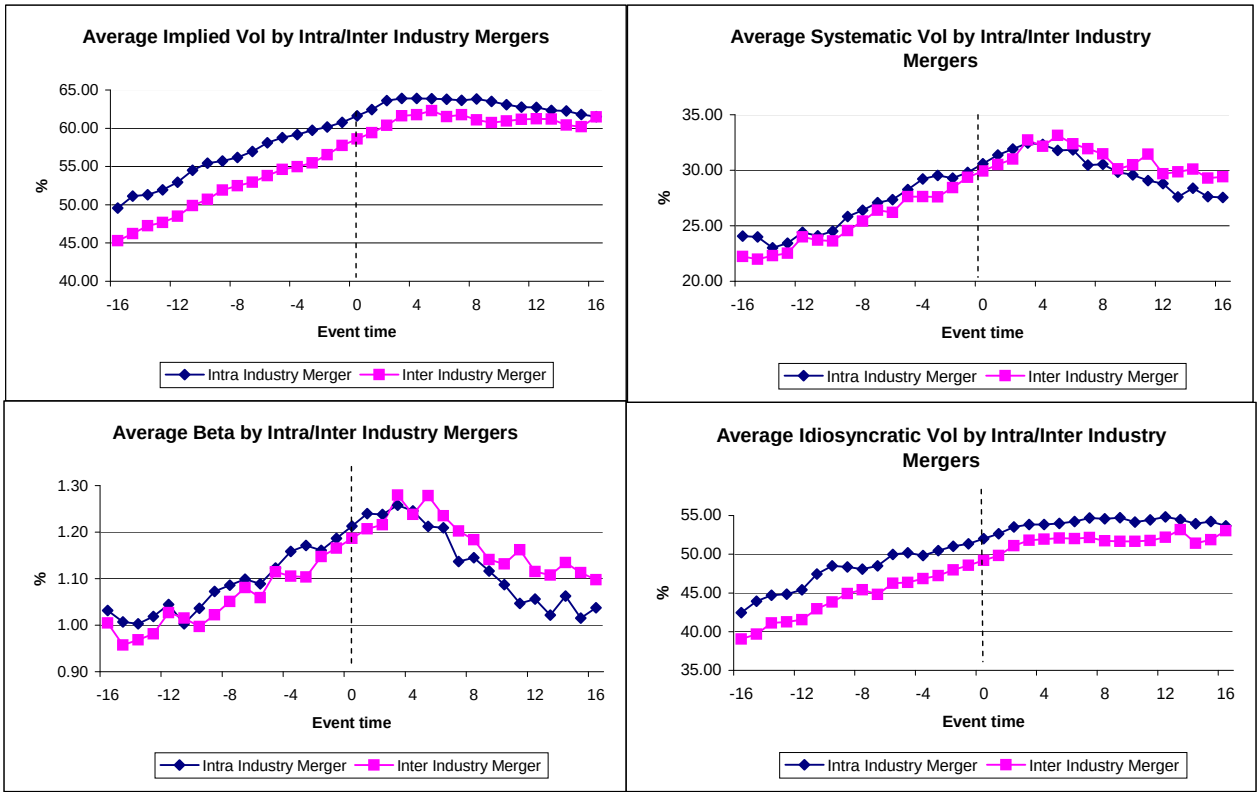

Figure 6: Diversification Discount and Cash Flow Patterns Around Mergers

This figure shows the behavior of the mean diversification discount (premium) and the mean ratio of cashflow to total assets of acquiring firms around the merger event by event time measured in years relative to the merger announcement date. Diversification discount (premium) is computed as the excess value measure based on asset multipliers following Berger and Ofek (1995). Cashflow is defined as the cash flow from operations taken from COMPUSTAT's statement of cashflows (annual COMPUSTAT data item 308 minus annual COMPUSTAT data item 124). Total assets is measured as the book value of total assets (DATA6) minus the book value of equity (DATA60) plus the market value of equity. Market value of equity is obtained from the CRSP database as the product of shares outstanding and the closing stock price. The sample period is from 1990 to 2002.