Mergers Increase Default Risk

Craig H. Furfine
Kellogg School of Management
Northwestern University
2001 Sheridan Road
Evanston, IL 60208
c-furfine@kellogg.northwestern.edu

Richard J. Rosen
Federal Reserve Bank of Chicago
230 S. LaSalle St.
Chicago, IL 60604
rrosen@frbchi.org

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Abstract: We examine the impact of mergers on default risk. Despite the potential for asset diversification, we find that, on average, a merger *increases* the default risk of the acquiring firm. This result cannot solely be explained by the tendency for generally safe acquirers to purchase riskier targets or by the tendency of acquiring firms to increase leverage post-merger. Our evidence suggests that manager-related issues may play an important role. In particular, we find larger merger-related increases in risk at firms where CEOs have large option-based compensation, where recent stock performance is poor, and where idiosyncratic equity volatility is high. These results suggest that the increased default risk may arise from aggressive managerial actions affecting risk enough to outweigh the strong risk-reducing asset diversification expected from a typical merger.

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Why do firms merge and how do mergers affect them? Much of the focus in answering this question has been on whether mergers create value, and if so, for whom. We propose to look at these issues from a different angle. An acquisition not only affects a firm's potential return stream but also changes the firm's risk, including its chances of going bankrupt. In this paper, we examine the impact of mergers on default risk, finding that, on average, a merger *increases* the default risk of the acquiring firm. This fact is starkly at odds with the presumption of the merger literature. For example, Amihud and Lev (1981) assert, "A conglomerate merger generally leads, through the diversification effect, to reduced risk for the combined entity."

After documenting that mergers are generally risk increasing, we turn to examining possible reasons why this might occur. Our finding of an increase in acquirer default risk might simply reflect the acquisition of risk from the target. We argue that this is not the case in two steps. First, we explore the mergers for which we have risk information for both the acquirer and target prior to the acquisition. We show that overall risk after a typical merger is *above* that of a pro forma combination of the acquirer and the target. Then, to broaden the focus, we use the corporate status of the target as a proxy for its riskiness. Many acquisitions in our analysis reflect the purchase of a private firm by a publicly-traded firm and we expect that private firms are riskier than public firms. We show that acquirer risk rises substantially for both public and private targets.

A second potential explanation of our findings is that acquirer default risk rises due to changes in financial leverage. As has been documented in the literature, firms increase their leverage following mergers (e.g., Ghosh and Jain, 2000). Morellec and Zhdanov (2008) develop a theoretical model which predicts that firms that win takeover battles will have low leverage, and therefore, acquirers should increase leverage post merger. This might be the reason for the increase in risk we observe. For two reasons, however, we are skeptical that changes in leverage are the proximate cause of our finding. First, Amihud and Lev's (1981) intuition is valid. Asset diversification means that the combination of two imperfectly correlated firms should, absent any countervailing action by the acquiring firm's managers, lead to a reduction in default risk for the

combined entity. Although it may make sense for firms to counteract some of the risk reduction induced by asset diversification by taking greater advantage of the tax shield provided by debt (Lewellen, 1971) or recapture wealth from bondholders (Kim and McConnell, 1977), theories have thus far not provided reasons for why a firm might increase leverage to the extent that such actions would *outweigh* the decline in risk arising from diversification. By contrast, recent work by Leland (2007) suggests that the merging of firms will tend to lead to increased leverage and *lower* probability of default. Seen in this light, our results remain puzzling. Second, and perhaps more directly, we document that acquirer default risk *increases* after controlling for the acquirer's change in leverage and even following mergers after which acquirer leverage *decreases.*

Having examined readily available explanations, we explore other, more subtle possibilities suggested by previous research. Managers might make acquisitions that increase risk because of the private benefits that flow from them. It has been shown that acquisitions generally increase managerial compensation, including bonuses, even when shareholder wealth declines (Bliss and Rosen, 2001; Grinstein and Hribar, 2004). More recent evidence (Cai and Vijh, 2007; Harford and Li, 2007) documents that the *form* of compensation might influence takeover decisions. In particular, these papers find evidence linking option-based CEO compensation and acquirer stock performance. One way for a manager to increase option-based compensation is to increase risk. Consistent with this, when we examine the correlation between compensation and acquirer risk changes following an acquisition, we find that post-merger default risk is increasing in the share of acquirer CEO compensation that is from stock options.

Another reason why mergers might increase risk relates to the role of asymmetric information. Moeller et al. (2007) find that proxies for asymmetric information are helpful in predicting acquirer stock returns. When there is more asymmetric information, managers are better able to hide potentially value-decreasing activities from outside shareholders. One indication of asymmetric information is idiosyncratic stock volatility, higher values of which may make it easier for managers to hide risk-increasing actions because they might simply be interpreted as reflecting a random outcome of greater ex ante uncertainty (Dierkens, 1991). We find a strong link between idiosyncratic volatility and increases in acquirer default risk, consistent

with asymmetric information allowing firm managers to better hide risk-increasing mergers from outside shareholders.

We then explore whether issues of valuation might help explain our results. For instance, firms whose stock price is perceived to be overvalued might be more willing to undertake a risk-increasing acquisition, consistent with the findings that the method of payment as well as measures of stock misvaluation impact both announcement and post-merger acquirer stock returns (see, e.g., Dong, et al., 2006; Rhodes-Kropf, et al., 2005; Shleifer and Vishny, 2003).[1] However, our results present something of a puzzle in that our findings suggest that stock acquisitions increase risk *less* than other mergers and that risk-increasing mergers are typically preceded by *poor* rather than strong acquirer stock performance.

Our paper's main contribution is to document that mergers, on average, increase the default risk of the acquiring firm. Our finding that default risk increases are best explained by a firm's idiosyncratic volatility, option-based managerial compensation, and poor acquirer stock performance pre-merger suggests that managerial issues may be important. In our conclusion, we suggest future research that would further examine the root causes of our findings.

The remainder of the paper proceeds as follows. We describe the data used in the study in section I. Then, in section II, we document that acquisitions typically lead to an increase in acquirer default risk. Section III presents preliminary evidence on the likely explanations for this finding. We provide a more thorough investigation of how changes in risk correlate with observable characteristics of the merger in section IV. We present our conclusions in section V.

I. Data description

We measure risk using the Expected Default Frequency (EDF) developed MoodysKMV (KMV).[2] The EDF is an estimate of the probability that a firm defaults in the next year. We have

[1] The earliest exploration of the relationship between mergers and stock overvaluation is perhaps Travlos (1987), whose analysis follows the argument made by Myers and Majluf (1984).

[2] In addition to our deeper exploration of the risk impact of mergers, we believe our use of EDFs is a methodological improvement over previous studies that look at the merger-related change in bond prices. Because we measure default risk without relying on the prices of publicly traded bonds, we avoid trading and liquidity issues, maturity, call provisions, convertibility, seniority, and a host of other factors that have been shown to affect the price of publicly traded bonds. Further, we are able to include a larger variety of acquiring firms since we do not require a firm to have public debt nor do we require such debt to be actively traded.

EDF data for the period July 1993 through September 2006 for firms in the KMV North American database.[3]

The calculation performed by KMV in its derivation of a firm's EDF can be viewed as a two-step process, where the first step uses relatively standard finance theory and the second relies on the proprietary default database owned by KMV. Using an internally developed extended version of the Merton (1974) model, KMV calculates a distance to default measure for each firm for each month. This is a technically demanding but theoretically straightforward computation that involves calculating a firm's asset volatility by de-levering its equity volatility (calculated from daily stock price changes) using data on a firm's capital structure (from its most recent publicly available balance sheet).[4] Once asset market value and volatility are derived, distance to default is simply calculated as

$$\frac{\text{market value of assets} - \text{book value of debt}}{\text{market value of assets} * \text{asset volatility}}.$$

This distance to default measures the number of standard deviations away from default a firm's current asset value is.

One can imagine employing a variety of statistical distributions to translate distance to default into a default probability. Primarily because default is an extremely low probability event and statistical distributions have generally restrictive allowances for large deviations from average, the major value added by the KMV product is its mapping of each firm's distance to default into a one-year default probability using a historical empirical distribution of defaults. For example, if KMV calculates a firm to be seven standard deviations from default, it uses its historical database to find that a firm seven standard deviations away from default actually defaults within one year 0.05% of the time. In this example, KMV would report this firm to have an EDF of 0.05% (five basis points).

An alternative approach would be to use the methodology of Bharath and Shumway (2008) to create measures of default probability without relying on the KMV database. When we employed

[3] KMV covers most, but not all, firms traded on major stock exchanges.

[4] This is done by expressing the observed equity value and equity volatility as implied-option related functions of a firm's asset value, asset volatility, capital structure, and the risk free rate. These two equations can be solved for the implied asset value and asset volatility in much the same way that option traders can solve for implied volatility from option prices.

their methodology on our sample, close to half of our acquiring firms had a zero default probability. This is consistent with the results reported in their paper (see their Table 1). Because of the large fraction of firms estimated to have zero default risk, we believe the Bharath and Shumway methodology is not well-suited for estimating default risk changes. We discuss this further in Appendix 1.

Our second major data source is the Securities Data Corporation's Merger database (SDC). To match merger information with KMV data, we first restrict the merger to have been announced and completed between January 1, 1994 and March 31, 2006. To focus our attention on mergers that can reasonably be expected to have an impact on acquirer default risk, we examine only those where the acquirer purchases at least 50% of the target firm and where the acquirer's post-merger ownership of the target exceeds 90%. We further impose the restriction that the ratio of deal size to acquirer's total assets is at least 5% but no more than 150%.[5] This eliminates a fair numbers of mergers that we expect to have little or no impact on overall acquirer default risk because the target is only a tiny fraction of the acquirer size. We also eliminate mergers for which the time elapsed between announcement and completion is greater than one year.[6] We further drop all mergers undertaken by acquirers with an EDF greater than 15%, since they are already close to default.[7] As is common in the corporate finance literature, we also eliminate acquisitions by firms in regulated industries such as banks and utilities.

We also require information regarding acquirer stock returns and balance sheet changes. For this information, we employ data from CRSP and Compustat, respectively. Mergers for which we could not obtain acquirer data from CRSP and Compustat were dropped.

Some firms make a series of acquisitions within a short period. We average across all acquisitions that are within twenty four months of another acquisition by the firm. This collection of mergers is then treated as a single merger beginning with the announcement of the first

[5] Our 5% threshold eliminates most, but not all, very small targets. We confirm in robustness checks that a further screen based on a target's absolute size does not affect our results.
[6] We drop mergers with a long time between announcement and completion to maintain consistency with previous literature. However, we confirmed that the time between the announcement and effective dates of a merger is not correlated with the change in risk surrounding the merger.
[7] According to Moody's (2007), a 15% EDF corresponds to a bond rating of between Caa and C.

acquisition and ending when the last merger in a series is completed.[8] Dropping all mergers associated with repeat acquirers does not change our qualitative results. Our baseline dataset consists of the mergers in SDC that satisfy our conditions and for which the acquirer is contained in the KMV, CRSP and Compustat databases. Our main sample consists of 3,604 merger events.

To explore the relationship between executive compensation and the risk consequences of mergers, we include data from Execucomp. As the Execucomp data is limited to larger firms, our sample size when compensation variables are included is reduced to 1,194.

II. Mergers add default risk

Our main finding is that mergers increase acquirer default risk.[9] We construct a variable ΔEDF that is the difference between the acquirer's EDF six months following the merger effective date and the acquirer's EDF one month prior to the merger announcement date:

$$\Delta EDF = EDF_{c+6} - EDF_{a-1},$$

where c is the month in which the merger is completed and a is the month in which the merger is first announced. We wait for six months following the merger completion to construct our measure of the change in acquirer risk because the EDF calculations are based on both market and balance sheet information. Since balance sheets are not updated until a firm releases new financial information, our six-month waiting period following a merger ensures that the balance sheet information used by KMV reflects the merged firm.[10]

Mergers generally lead to an increase in default risk for the acquiring firm, as can be seen in the second row in Table 1. The mean increase in one-year default probability is 0.520% across all

[8] We use weighted average values for all variables (except the total value of targets acquired) associated with these merger events, where the weights are the price paid for the target.

[9] Although we believe our work is the first to focus on the impact of mergers on the risk of the acquiring firm, other papers have indirectly addressed this question by examining mergers' impact on the prices of publicly traded bonds. For example, Maquieira et al. (1997) explore whether corporate mergers create value or merely transfer value across debt and equity claimholders by examining the stock and bond price reactions to merger announcements. Although not central to their analysis, they show that prices of acquiring firms' bonds rise following the announcement of a merger between firms in the same industry, but not between firms in different industries. Billett et al. (2004) conduct a similar study, finding, on average, a statistically significant but relatively small decline in the price of the acquirer's bonds following merger announcements.

[10] Our results are robust to other time horizons.

3,604 mergers.[11] To put this percentage in perspective, consider that the mean level of default probability for acquirers one month prior to a merger announcement, EDF_{a-1}, is 1.370%. The change in EDF is statistically and economically important. To illustrate, consider that increasing default risk, as measured by a higher EDF, leads to increased funding costs. Assuming a 40% loss given default, a 52 basis point increase in default risk leads to a 21 basis point increase in the cost of debt. This is a large increase. For example, a 1.370% default rate is consistent with a BB+/BB rating (see Moody's (2007)) and, over our sample period, the average spread between BB+ and AAA corporate bonds was 190 basis points. Thus, a 21 basis point increase to a firm's cost of debt is as economically large as a firm moving 11% of the way from having AAA-rated debt to having to issue junk bonds.

An alternative way to look at risk changes is to examine the percentage change in risk. A given increase in risk can be more important to a safe firm than to a risky one. Define the percentage change in EDF surrounding a merger as:

$$\Delta EDF\% = EDF_{c+6} / EDF_{a-1} - 1.$$

The third row in Table 1 shows that acquirer risk rises an average of 94% surrounding a merger. This is largely the result of big increases in risk by some safe acquirers.

Before the availability of EDFs, it was common to use credit ratings to proxy for default risk. For many reasons, EDFs are a better measure of default risk than credit ratings. First, EDFs capture relatively small changes in risk. Credit ratings, however, are lumpy by design, and do not change unless underlying default risk changes significantly. Second, credit ratings are designed to be far more stable than changes in short-run (e.g. one-year ahead) measures of default risk (Altman and Rijken (2004)). Therefore, updates to a firm's credit rating will often lag changes in risk. Thus, we cannot be confident that even six months after an acquisition, a firm's credit rating will have adjusted to changes in risk caused by the merger. Finally, credit ratings are generally only available for firms with traded public debt. Using credit ratings as a measure of default risk generates a sample of only 832 mergers, far smaller than the 3,604 mergers for which we have KMV EDFs.

[11] We winsorize all variables except the raw EDFs at the 5% level to control for outliers. For balance sheet, stock market, and compensation variables, we winsorize using the entire universe of firms in the data. For merger variables, we winsorize in sample.

Despite these deficiencies, we report changes in credit ratings surrounding a merger. We take the S&P credit ratings as given in Compustat. The letter ratings are converted to numbers by assigning the value 1 to AAA+, 2 to AAA, 3 to AAA-, 4 to AA+, and so on (there are no plus/minus notches for ratings CCC and below). Summary statistics for credit ratings and their changes are reported in Table 1. In this much smaller sample of mergers, the mean credit rating is 12.26, which corresponds to a weak BBB- rating. On average, there is a 0.11 increase in credit rating surrounding a merger, consistent with our findings for EDF. Most acquirers, however, have no change in credit rating from prior to a merger until six months after the merger (hence the 0.00 median change in rating). As noted, this is misleading because credit ratings are lumpy so moderate increases in risk may not be captured by changes to credit ratings and because credit rating changes tend to lag changes in risk. We can do nothing about the first issue (except use EDFs), but we can address the second by looking at the credit rating at the first quarter end at least 12 months after a merger is completed (that is, c + 12 rather than c + 6). Using this longer horizon yields a larger increase in credit ratings of 0.20.[12] Again, this is consistent with our results for EDFs. Due to the much smaller credit rating sample and the tendency for ratings to change only with a significant lag, the remainder of our analysis will focus on EDF-based risk measures. We have repeated all the analysis using our credit rating data and find qualitatively similar results, although for the reasons described above, our statistical significance is often weaker.

III. Why mergers might add default risk

In this section, we discuss whether the finding that mergers add default risk is surprising, and we examine the empirical support for different reasons why mergers might systematically affect risk.

The most obvious possibility is that risk may not be generated by an acquisition but merely transferred. Since the findings of Section II are based only on acquirer risk, it may be that the typical merger is risk-increasing from the acquirer's point of view because the typical target has

[12] We have examined even longer horizons. The results are similar to those for the 12-month horizon, suggesting that much of the information from a merger is captured in credit ratings within one year of the merger's completion.

more default risk than the typical acquirer. We can explore this directly only for the 370 mergers where we also have EDF data for the target. For this subsample of mergers, the average acquirer EDF prior to merger is 0.740%, below the full sample average in large part because firms that acquire public targets tend to be larger than other firms, and thus, safer on average. Still, as with the full sample, these acquirers are riskier after their mergers than before, with a mean ΔEDF of 0.313%, leaving the merged firm with an EDF of 1.053%. Given that the mean EDF of the targets in these mergers is 2.663%, this may not seem like a large increase. However, this ignores two factors: the targets are smaller than the acquirers and there is asset diversification. The effect of these two, especially asset diversification, is large. If we assume stock returns are normally distributed, and use the pre-merger correlation between acquirers and targets, then the average EDF of a pro-forma combination of an acquirer an a target is 0.595%, well below the pre-merger EDF of acquiring firms.[13] Thus, since the post-merger EDF averages 1.053%, risk increases relative to the pro-forma combination by 0.458%.

As further evidence that the increase in risk is not just a transfer from targets to acquirers, we can split the target-EDF subsample by whether the target is riskier than the acquirer. The first two lines of Table 2 report data for the 370 mergers for which we have target EDF data. For the 59 of these mergers involving the acquisition of a target with *less* default risk than the acquirer, acquirer default risk still *increases* following the merger, with an average gain of 0.337%. Surprisingly, for the 311 mergers where the target is at least as risky as the acquirer, the merger increases the risk of the acquirer by a slightly smaller 0.308%, although the difference in magnitude is not statistically significant. Of course, this increase in risk could be due to the riskier targets, but if we do the same pro forma experiment as earlier, we find that this is not the case. Thus, acquirers get riskier whether or not they acquirer a risky target and, even for risky targets, the additional default risk is created by the merger and not a function of risk transfer. When we examine the percentage change in EDF rather than level changes, the results are even stronger. The mean percentage change in EDF is now statistically significantly larger for mergers where the target is safer than the acquirer than for mergers where the target is riskier than the acquirer and risk is found to increase for mergers in both groups.

[13] We present the formal argument and discuss the distributional assumption in Appendix 2.

To provide evidence on risk transfer in the broader sample, we can use the ownership status of the target prior to the merger. As a general rule, private firms would be expected to be riskier than public firms. The next three lines of Table 2 report mean values of *EDF*, *ΔEDF*, and *ΔEDF%* broken into subsamples based upon whether the target firm is (1) public, (2) private, or (3) a subsidiary of another firm (where we are not certain of the relative risk of subsidiaries). The evidence suggests that the acquisitions of all types of targets lead to increases in risk. This is additional evidence that, although the transfer of target risk may play a role in our result, the type of target being acquired is not likely to completely explain the increase in acquirer default risk following an acquisition.

Another reason that mergers may increase risk is that, in response to a merger, acquirers tend to increase their financial leverage (e.g., Ghosh and Jain, 2000; Morellec and Zhdanov, 2008). To examine this, we measure leverage changes for a similar period to that we use to measure changes in EDF. We set pre-merger leverage as of the quarter-end closest to but not earlier than the end of the month prior to the merger announcement (the date of the pre-merger EDF). We use the quarter-end data coming as close to but not sooner than six months after the merger has been completed (the date of the post-merger EDF) to measure post-merger leverage. Consistent with prior work, out of our sample of 3,604 mergers, financial leverage increases surrounding 2,040 mergers, roughly 57% of the sample. As preliminary evidence that leverage changes are not the proximate cause of our finding, the next two rows of Table 2 report our risk measures broken into two subsamples depending on whether the financial leverage of the acquiring firm increases or decreases. For the set of mergers where the financial leverage of the acquirer risk increases, default risk increases by 0.734%. However, acquirer default risk rises by an average of 0.240% even when the financial leverage of the acquiring firm declines following the merger. Thus, even when changes in leverage (and, presumably, asset diversification) work to make the combined firm safer, risk still increases.

To consider more carefully the effect of leverage, we estimate the part of our merger-related change in risk, *ΔEDF*, that is unrelated to changes in leverage. Using the acquirer's equity-to-asset ratio (*EQ/TA*) as (an inverse) measure of leverage, we find that leverage increases do

correlate with increases in acquirer default risk (as they should be expected to do since leverage is a key input into KMV's calculation of EDFs). Our regression estimates are:

$$\Delta EDF = 0.487 - 5.70\ \Delta EQ/TA$$

with an adjusted R-squared of 0.048. As these results show, however, leverage is far from a complete explanation of our key finding. First, the R-squared of this regression is less than 0.05, implying that leverage explains little of the variation in risk changes that we observe. Second, the constant term in the regression, reflecting the average change in risk after controlling for leverage changes, is 0.487% – a number not economically different from 0.520%, the unconditional estimated average change in risk reported in Table 1.

Having ruled out the most obvious explanations of our findings, we now consider the possibility that risk increases surrounding a merger result from actions taken to benefit managers. There is evidence that mergers increase the private benefits of managers even when they do not benefit a firm's shareholders (Bliss and Rosen, 2001). Managers whose compensation is largely comprised of options on company stock benefit financially – all else equal – from higher stock volatility. Volatility, in addition to increasing the value of options-based compensation, may also increase a company's default risk. We can examine the relationship between options-based compensation and default risk for a subsample of 1,194 mergers for which the CEO of the acquiring firm is listed in the Execucomp dataset. For these mergers, we calculate the fraction of the CEO's compensation that is derived from options and split the sample at its median value of 35%. The next two entries in Table 2 report the average change in default risk for the high and low options-based compensation samples. The results are consistent with the risk-increasing incentives provided by stock options. In particular, acquisitions done by firms with CEOs with above-median option-based compensation lead to greater risk increases than those completed by other CEOs. In our sample, acquisitions by highly option-compensated CEOs increased default risk by 0.328% whereas other mergers in our compensation subsample increased risk by only 0.167% on average.[14] These results suggest that the form of executive compensation influences the degree to which mergers increase risk. However, as in the other cases, executive

[14] Our results are qualitatively similar for $\Delta EDF\%$ although the differences are not statistically significant.

compensation does not seem to be the entire story as risk tends to increase even among mergers by CEOs with below-median option-based compensation.

High idiosyncratic volatility in firm stock returns can be a sign of companies that have more asymmetric information between management and shareholders (Dierkens, 1991; Moeller, et al., 2007). If this were true, then managers of such firms might be more willing to make risk-enhancing acquisitions because their actions remain more hidden from shareholders. Consistent with this, there is evidence that idiosyncratic volatility is negatively correlated with investment, especially at firms where there might be agency problems (Panousi and Papanikolaou, 2008). Since acquisitions can be thought of as a type of investment, it may be that high idiosyncratic volatility is associated with risk-increasing mergers. We construct measures of idiosyncratic stock volatility for each of our acquirers by taking the standard deviation of the residuals from a regression of acquirer daily stock returns on the return of the CRSP value-weighted index using daily data from the six-month period ending at the end of the month preceding the merger acquisition. The next two lines of Table 2 indicate the relationship between idiosyncratic volatility and the change in risk associated with mergers. Breaking our sample at the median value of approximately 3%, we find that acquisitions by firms with above-median volatility increase risk by 0.861% on average. In contrast, acquirers with below-median volatility still increase risk following the merger, but by a much lower amount of only 0.179%. This suggests that idiosyncratic volatility may also be a predictor of acquirer willingness to increase default risk.

The literature has paid a lot of attention to the role of stock market valuation in the decisions of whether and which firms to acquire. Thus, a firm's stock recent stock performance might be relevant to understanding our finding that default risk increases after mergers. In general, when a company's stock has recently performed well, managers may perceive that it is cheaper to make acquisitions, in part, with more valuable stock. These incentives become stronger when managers are of the belief that the stock is overvalued. While in this paper we do not examine the accuracy of stock valuation, we believe that recent company stock performance might affect the willingness not only to undertake mergers in general, but to be willing to undertake mergers that might increase risk. The idea is that being able to acquire a firm at an implicitly lower cost (since

one's own stock is valuable) makes managers more willing to accept a merger that has risk-increasing attributes.

We measure recent stock performance in two ways. First, we examine the buy-and-hold return of a company's stock in the 12 months ending at the end of the month prior to the merger announcement in excess of the return of the CRSP value-weighted index over the same period. This variable measures recent stock performance, but may not reflect overall valuation to the extent that it ignores how the acquirer's stock had performed up until our measurement begins. We also consider the acquirer's market-to-book ratio, measured at the end of the month prior to the merger announcement. The market-to-book ratio might better capture overall stock valuation at the relevant point in time, but neglects information that might be contained in recent performance data.[15]

The next two rows of Table 2 present the average change in risk following mergers broken into subsamples based on whether the acquirer's stock has recently outperformed or underperformed the market over the six month period prior to the merger. Surprisingly, the results are *inconsistent* with overvaluation being important to understanding why risk increases following mergers. For acquisitions made by firms whose stock has recently outperformed the market, risk increases by an average of 0.377%. However, when a firm's stock has recently underperformed, acquirer default risk rises by 0.681%. That is, acquisitions by firms with underperforming stock tend to increase risk by more than other mergers. [16] This conflicts with the notion that risk-increasing mergers are encouraged when an acquirer's stock has done well.

The final two lines of Table 2 repeat the same analysis according to the acquiring firm's market-to-book ratio prior to the merger announcement. High market-to-book firms are somewhat safer than low book-to-market firms. When measured in levels (ΔEDF), there is no significant difference between the two groups in the increase in risk surrounding mergers. However, high market-to-book acquirers have a greater percentage increase in risk ($\Delta EDF\%$) than do low market-to-book acquirers.

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[15] The literature has argued that market-to-book ratios, to the extent that they measure growth opportunities, should be correlated with the decision to make acquisitions. See, for example, Jovanovic and Rousseau (2002) and Rau and Vermaelen (1998).

[16] Again, the differences reported for $\Delta EDF\%$ are not statistically significant.

IV. Which mergers add risk?

In the previous section, we presented some preliminary evidence on what may lie behind our result that mergers increase default risk. We undertake a more complete analysis in this section by considering a variety of possible determinants of the risk-increasing consequences of mergers in a regression framework, allowing us to control for correlations across many of the variables of interest. We run a standard regression model where the dependent variable is *ΔEDF*, which measures the change in the acquiring firm's expected default frequency from the end of the month prior to the merger announcement to the end of the month six months after the merger was completed.

Our choice of independent variables is guided both by our preliminary analysis of Section III and by our desire to control for other factors that might influence our interpretation of results. Summary statistics for both our dependent and independent variables are given in Table 3. To begin with our variables from the preliminary analysis, we include two dummy variables, *TARGET PUBLIC* and *TARGET SUB*, to control for the type of firm being acquired. In our sample, 20.1% of targets are publicly traded, 32.4% are subsidiaries, and 47.4% are private. In the regressions, we omit the private target category. Based on our earlier findings, we expect that the coefficients on these variables should be negative, indicating that the acquisition of non-private targets should, all else equal, lead to a reduction in risk for the acquirer.

For some of our analysis, we include *OPTIONS*, which measures the fraction of the compensation derived from stock options of the acquiring firm's CEO. We would expect greater options compensation to be correlated with greater risk-taking incentives and therefore, a positive coefficient in the regression model. Because we only have options holdings for a part of our sample, we conduct our analysis both with and without its inclusion.

We include the variable *VOL*, which measures the idiosyncratic volatility of the acquiring firm's stock. Based on our preliminary findings, we expect a positive coefficient, suggesting that higher levels of pre-merger volatility correlate with greater increases in risk post-merger.

We include *RUNUP*, the net buy-and-hold return of a company's stock in the 12 months ending at the end of the month prior to the merger, and *MKT-TO-BOOK*, the ratio of the market

value of equity to its book value as of the last quarter end prior to the merger, as controls for valuation effects. To the extent that these reflect valuation errors, we expect a positive correlation between stock performance and risk increases surrounding a merger. Recall, however, that this is not what the univariate statistics indicate.

In addition to the variables in our preliminary analysis, we also include a number of additional control variables. The first responds to evidence presented by Travlos (1987) and others indicating that the method of payment for a target is related to the market reaction and success of mergers. They argue that a firm's stock valuation impacts its decisions of whether and how to make acquisitions. As noted above, previous work implies that purchases using overvalued stock might be correlated with greater risk post merger. However, there is also another effect of the type of financing on the change in risk from a merger that points in the opposite direction. Financing with stock adds less risk than using cash, all else equal, because in a cash acquisition, the acquirer is replacing (safe) cash with the leveraged and risky balance sheet of the target. This suggests it is necessary to control for payment method in addition to stock valuation in our regression. To do so, we construct the variable *STOCK*, which is an indicator variable for whether the target is acquired through the use of at least some stock. Our omitted category of mergers is cash-financed acquisitions.[17] Among our 3,604 mergers, 46.1% involve at least some stock. Due to the conflicting theories, we have no prior expectation regarding the sign of the coefficient on *STOCK*.

Earlier studies have examined whether conglomerate firms are more efficient than single-industry firms (e.g., Lang and Stulz, 1994; Berger and Ofek, 1995) and whether conglomerating mergers have a different impact on firms than within-industry mergers (e.g., Servaes, 1991).[18] To explore issues related to conglomeration versus specialization, we define an indicator variable *CONGLOM* which equals 1 whenever the target and the acquirer are in different industries and 0 if they are in the same industry. We get our industry definitions from SDC, which divides firms

[17] A very few mergers in the SDC database are financed neither by cash nor stock. For instance, some mergers are financed with bonds or other liabilities; include royalties or other earnings payouts; or include assets on the acquirer's or target's balance sheets, third-party stock, or other forms of value. Mergers financed using only these factors have been eliminated from the sample.

[18] A recent cross-country study of mergers by Acharya, Amihud, and Litov (2008) finds that the choice of conglomeration versus specialization is affected by the strength of a nation's creditor rights, with strong creditor rights being associated with a greater likelihood of conglomerating mergers.

into 61 industry groups. In our sample, 20.9% of mergers involve firms from different industries. All else equal, one might expect cross-industry mergers to offer additional diversification benefits and therefore we expect a negative sign on the coefficient of *CONGLOM*.

The size of the target relative to the acquirer can affect the potential for risk to be affected by a merger. We capture relative size by constructing *RATIO* as the price paid for the target divided by the market value of the acquirer. We use the price paid for the target because for many of our mergers, the target is not traded and, thus, has no observable market value.[19] On average, targets are valued at 31.5% of acquirer market capitalization. The ratio of target to acquirer size has been found to affect the market reaction to a merger announcement (see, e.g., Asquith, et al., 1983) and thus we include *RATIO* to control for the possibility that it may be related to changes in risk. We have no prior on the sign of the coefficient on *RATIO*.

Acquirer size in and of itself might affect the change in risk if, for example, larger acquirers are more diversified and thus their risk is less affected by acquisitions. To control for this, we include the log of market value *(MKT VAL*) as a control.

We also explore whether the market reaction to a merger announcement carries information about whether the market thinks a merger will add risk. If shareholders believe the acquirer's risk will increase without a corresponding increase in expected return, then the share price of the acquirer should decrease. Thus, the market reaction to a merger announcement may be negatively correlated with expectations about changes in risk. Of course, since the market reaction also reflects information about expected return, this correlation might be weak. Define *CAR* to be the acquirer's cumulative abnormal stock return above the CRSP value-weighted index summed across days -1, 0, and +1 relative to the merger announcement. In our sample, the average *CAR* is 2.0%. This is within the range, although at the high end, of what other studies find.[20] This may be because we have a larger proportion of small acquirers, and the *CAR* is

[19] We considered using the market value of the target prior to the merger in the numerator of *RATIO* if it was available. However, because targets generally sell at a significant premium, this runs the risk of making *RATIO* systematically lower for mergers where the target is publicly traded.

[20] Studies that find negative average returns to acquiring firms include Asquith, et al. (1987), Banerjee and Owers (1992), Bradley, et al. (1988), Byrd and Hickman (1992), Jennings and Mazzeo (1991), Servaes (1991), Varaiya and Ferris (1987), and You, et al. (1986). See Table 8-6 in Gilson and Black (1995). See also the survey by Andrade, et al. (2001). The impact is especially pronounced for large acquirers and in the recent merger wave (Moeller, et al., 2004; Moeller, et al., 2005).

decreasing in acquirer size (Moeller, et al., 2004). Consistent with this, the *CAR* for large acquirers (over $1 billion in total assets) is 0.7%.

Finally, all the regressions include dummy variables for the year of the merger, the pre-merger risk category of the acquirer, and the industry of the acquirer. We include year dummies to control for the possibility that our finding that mergers increase risk is driven by secular changes. For example, if a merger takes place when risk is changing in the overall economy, then *ΔEDF* might reflect the economy-wide changes rather than the effects of the merger.[21] We include risk dummies to control for the possible correlation between an acquirer's initial risk level and the characteristics of the merger. For example, we saw in Table 2 that acquirers with greater idiosyncratic volatility tend to increase risk more following a merger. However, the data also reveal that such acquirers have a much higher initial default probability. Thus, we wish to control for the initial default probability as we investigate the role of idiosyncratic volatility. We do this by grouping firms into risk categories based on a rough translation of EDFs into credit rating equivalents.[22] Our dummy variables for industry control for differences in risk characteristics across industries.

Note that we do not include the change in acquirer leverage in our regression analysis. This is because our intent is to learn more about which mergers lead to greater increases in default risk based on data at the time of the merger. Our regression analysis thus isolates the merger-related characteristics that predict such risk increases.[23]

Our baseline regression results are presented in the first column of Table 4. The first rows report coefficients for the two variables that control for the type of target being acquired.

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[21] We doubt that secular changes in risk play a big role in our results. As a further check of this fact, we examined the evolution of EDFs in the entire KMV sample with the evolution of EDFs of acquiring firms. Risk increases more for acquirers than for firms on average during virtually every month of the entire sample period. When calculated on a yearly basis, the average increase in EDF for acquirers in our merger sample is greater than the average firm's 12-month risk increase in every year of our sample.

[22] The groups are as follows, expressed as (EDF range, group): (0.02, 1), (0.03-0.04), 2), (0.05-0.10, 3), (0.11-0.16, 4), (0.17-0.32, 5), (0.33-0.74, 6), (0.75-0.99, 7), (1.00-1.99, 8), (2.00-2.99, 9), (3.00-4.99, 10), (5.00-9.99, 11), (10.00-13.99, 12), (≥ 14.00, 13). These groups correspond to default rates for different rating classes of corporate bonds (with some high rating classes compressed, see Moody's (2007) for bond default rates).

[23] As a robustness check, we replicated all of our regressions, replacing the dependent variable *ΔEDF* with the residuals from a regression of *ΔEDF* on the change in acquirer leverage. After controlling for changes in leverage in this way, our conclusions regarding the key factors affecting the change in risk following a merger were qualitatively unchanged.

Although, as predicted, the coefficients on *TARGET PUBLIC* and *TARGET SUB* are both negative, neither is statistically significant.

The coefficient on idiosyncratic volatility, *VOL*, is positive and statistically significant. The magnitude of the coefficient implies that a one standard deviation increase in volatility increases the change in default risk by 0.441%. This is economically large, as our benchmark finding is that mergers lead to an increase in default risk of 0.520%. The increase is consistent with asymmetric information playing a significant role in the ultimate increase in default risk following mergers.

In line with the univariate tests, the coefficient on *RUNUP* is negative and significant while the coefficient on *MKT-TO-BOOK* is insignificantly different from zero. Thus, controlling for other factors, acquirers that have had poor recent stock performance tend to make acquisitions that increase default risk. A one standard deviation improvement in past stock market performance implies a 0.105% reduction in post-merger default risk, all else equal. As mentioned earlier, this is inconsistent with the suggested notion that the incentive to spend overvalued stock might lead managers to make risk-enhancing acquisitions.

We find that all else equal, acquisitions paid for, in part, with stock, lead to a reduction in default risk. Recall that we had two conflicting predictions regarding method of payment and default risk. Our negative coefficient suggests that the direct effect, namely the conservation of safe cash outweighs adverse incentive effects of paying with (potentially) overvalued stock.

If cross-industry mergers allow more risk-reducing diversification, then the coefficient on *CONGLOM* in Table 4 should be negative. It is not. The coefficient is positive, although it is not significantly different from zero. This suggests a cross-industry merger is no more likely to diversify risk than is a merger between two firms in the same industry.

The ability of an acquisition to change the risk of the acquiring firm is a function, at least in part, of the relative size of the target and the acquirer. A target that is very small relative to its acquirer is likely to have little impact on the acquirer's overall risk. This motivates our decision to restrict the sample to targets that are at least 5% the size of the acquirer (where we measure relative size using *RATIO*). Viewed in this way, if large targets are similar to small targets in all ways but size, the coefficient on *RATIO* should be positive since the average merger increases risk. This is what we find.

Large acquirers may be more diversified than smaller acquirers, all else equal. If they are diversified, then an acquisition could have a smaller impact on risk. Consistent with this, risk increases less for large acquirers than for small ones, as evidenced by the negative coefficient on *MKT VAL*.

Finally, we find there is a negative correlation between the market reaction to a merger announcement and the increase in risk from the merger. As shown in the first column of Table 4, for every percentage point increase in the CAR, risk decreases by 1.3 basis points. The CAR represents the market's view of the merger, which might be affected by the expected change in risk from the merger. That is, the CAR may be a proxy for whether a merger is intended to increase the value of the firm or the private benefits of the firm's managers. However, there is also a direct effect of the announcement return on the risk of the firm. One of the factors in the derivation of a firm's EDF is the market value of the firm's equity. Thus, there is a mechanical relationship between changes in the stock price and changes in the EDF much like there is a direct effect between leverage changes and changes in risk. As we are trying to isolate the merger *characteristics* from the merger *outcomes*, we ideally want to isolate the informational component of the CAR from the mechanical linkage between CAR and ΔEDF.

To do so, we wish to eliminate the part of the CAR that becomes part of the acquirer's stock return during the time period over which we measure changes in default risk. Define *RETURN INTERIM* as the return on the acquiring firm's stock net of the CRSP value-weighted index in the period starting with the month the merger is announced and ending the end of the month six months after the merger is completed. That is, *RETURN INTERIM* is measured over the same period that we measure default risk changes. We regress *CAR* on *RETURN INTERIM* and call the residual from this regression as *CAR RESID*. The second column of Table 4 reports the results when we replace *CAR* with *CAR RESID* while leaving all other aspects of the regression unchanged. Although all the other coefficients are virtually unaffected, the coefficient on *CAR RESID* is not significantly different from zero. This suggests *CAR* serves as a proxy for the overall change in value of the firm in the interim period rather than as a signal of the riskiness of the merger.

We also want to control for the possibility that mergers are being used as a mechanism to achieve a desired level of default risk. That is, our reported coefficients might be correlated with characteristics of the acquiring firm that indicate a firm's desire to change its default risk. There is evidence that firms may use acquisitions to adjust leverage toward a more preferred level (Uysal, 2007). Thus, it is possible that firms use acquisitions to move toward a target level of default risk. We adapt Uysal's (2007) empirical model of optimal capital structure to estimate a firm's target default risk.[24] Having done so, we construct the variable *DISTANCE FROM DESIRED RISK* as the residual from our target risk estimation model. A positive value implies that a firm's initial risk level is above its desired level, and therefore we would expect to find a negative coefficient for *DISTANCE FROM DESIRED RISK*.

The third column of Table 4 reports the results of regressions including the distance a firm is from its target default risk as a control variable. The coefficient on *DISTANCE FROM DESIRED RISK* variables is negative, as expected. That is, when a firm is above its target risk level, it uses mergers to reduce risk while when it is below the target, it wants to increase risk. The signs and magnitudes of the other coefficients are similar to those reported earlier. This suggests that our observed risk increase might arise in part but not entirely from firms using acquisitions to move toward target risk levels.

As a robustness check, we repeat the regression in column (3) of Table 4 using the percentage change in EDF as a measure of risk. The results, reported in the fourth column of the table, are qualitatively similar with one exception. The coefficient on *RUNUP*, while negative as in the other regressions, is not significantly different from zero. It turns out that this is because acquirers with very high pre-acquisition stock price increases, roughly the top 10% of acquirers by *RUNUP*, make acquisitions that look like those of acquirers with very poor pre-acquisition stock performance. Perhaps the simplest way to see this is to add a dummy variable for the high runup banks. Let *RUNUP TOP 10* be a dummy variable that takes the value 1 if an acquirer has a pre-acquisition stock price increase in the top 10% and takes the value 0 otherwise.[25] The final

[24] The target risk model regresses observed default risk on acquirer market-to-book, EBITA/SALES, ASSETS, R&D/SALES ratio, an R&D dummy, and PPE (property, plant, and equipment expenditures).

[25] When we included dummy variables for the *RUNUP* deciles, there was a distinct jump in the coefficients between the top 10% and the next 10%. There was no such jump between the other deciles. To simplify the presentation,

two columns of Table 4 include the *RUNUP TOP 10* variable. The results are qualitatively similar for either *ΔEDF* or *ΔEDF%* as the dependent variable. The coefficients on *RUNUP TOP 10* are positive and significant while the coefficients on *RUNUP* are negative and significant, suggesting again that poor pre-merger stock performance correlates with merger-related increases in default risk, at least for the large majority of firms.[26]

Table 5 presents the results from regressions where we include data on the options held by acquiring firm CEOs. For ease of comparison, the first column of Table 5 replicates our benchmark findings and is copied from column (3) of Table 4. As mentioned, we only have compensation information for 1,194 of our 3,604 total mergers. We control for this reduction in sample size in two ways. In column (2) of Table 5, we add a dummy variable that equals 1 for all mergers for which we have compensation data and equals 0 otherwise. The remaining two columns are estimated only on the 1,194 observations with compensation data.[27] Regardless of which approach we choose, the coefficients on the previously discussed variables are little changed. The purpose of examining the compensation data is to determine whether the form of executive compensation affects the risk-increasing nature of acquisitions. The variable *OPTIONS* measures the fraction of the compensation of the acquiring firm CEO that comes from stock options. All else equal, we expect that greater risk taking of a firm might simultaneously increase the value of executive stock options and the default risk of the firm. The positive and statistically significant coefficient on *OPTIONS* implies that CEO's compensated most by options tend to make the most risk-increasing acquisitions. The economic magnitude of this result is large, too, with a one standard deviation increase in options compensation implying a 0.089% increase in default risk following an acquisition, 36% of the average default risk increase in the sample of mergers with compensation data (using the regression estimates from column 4).

The regression results in this section confirm the univariate analysis. The increase in default risk surrounding mergers is driven by firms with higher idiosyncratic risk and poor previous stock

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only *RUNUP TOP 10* is included in the regressions presented in Table 4. Also, note that there was no similar jump for firms in the top 10% of two other key independent variables (*VOL* and *MKT-TO-BOOK*).

[26] We can use the coefficients from the regression in column (5) to illustrate how different firms in the top 10% are. For these firms, the mean value for *RUNUP* of firms is 1.34. At this value, the net effect of pre-acquisition stock price changes is -0.16 (from -0.295 * 1.34 + 0.231). This is comparable to a firm with *RUNUP* equal to 0.56.

[27] *RUNUP TOP 10* is not included in the regressions. It is insignificant for the sample with compensation data.

performance and those where a larger share of managerial compensation is options based. This holds even after controlling for other factors known to affect merger performance.

V. Summary and conclusion

There is an extensive literature exploring why firms merge, and our empirical findings allow us to comment on a variety of theoretical motivations for undertaking mergers. In part, the extant literature is motivated by findings suggesting shareholders of acquiring firms do not obtain large increases in value and may even lose value following a merger. In contrast to much of this prior work, we explore the extent to which mergers offer diversification benefits. Our key finding is that despite the potential for asset diversification, we find that, on average, mergers are associated with increases in default risk.

We further document that many of the most obvious explanations of this finding are not supported by the data. In particular, the risk-increasing nature of mergers is not driven by the transfer of default risk from the target to the acquirer or by dramatic increases in leverage post acquisition. Our findings highlight three factors associated with acquiring firms that indicate increased default risk surrounding mergers. First, we document that firms with high levels of idiosyncratic risk generally have a larger default risk after an acquisition than before. Second, we find that risk increases more at firms where CEOs have a larger share of option-based compensation. Third, risk-increasing mergers are preceded by poor stock performance of the acquiring firm. On the other hand, our results indicate that risk-increasing mergers are not the result of acquisitions facilitated by overvalued stock. After controlling for other factors, mergers financed with stock tend to be correlated with risk *reduction*.

Much of the examination of why firms merge focuses on the extent to which merger decisions are driven by the private benefits of those making the decisions rather than fundamental factors such as possible synergies. Each of the three characteristics we associated with risk-increasing mergers can be interpreted as consistent with the private benefits motivation for mergers. Firms with high levels of idiosyncratic risk may require active management. More active managers may think they can manage a post-acquisition firm better than they actually can (Roll, 1986), which leads them to be more risk tolerant. This hubris can explain the correlation between idiosyncratic

risk and post-merger increases in default risk. More directly, managers may take actions to directly increase their compensation (Bliss and Rosen, 2001). Compensation that is risk based gives managers an incentive to take actions that add to firm risk. Acquisitions and the related restructuring (Maksimovic, et al., 2008) may be an efficient way to do so. Such behavior might explain the observed positive correlation between the share of compensation that is options based and risk increases surrounding mergers. Finally, poor stock performance might proxy for management that is pursuing its own goals rather than solely attempting to maximize shareholder value. It may be that such performance indicates low-quality, entrenched management (Masulis, et al., 2007), so managers of these firms have less fear from being replaced if they use risk-enhancing mergers as a way to gamble on the firm's future stock performance. This can explain why firms with poorly performing stock have larger risk increases surrounding mergers than do other acquirers. While our results are consistent with these managerial motivations for mergers, our analysis does not rule out other explanations. We leave that for future research.

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Appendix 1. Comparison of MoodysKMV EDF to an alternative

We measure default risk using the expected default frequency (EDF). The EDF, a measure of the probability that a firm defaults over the next year, is available from MoodysKMV. Bharath and Shumway (2008) offer an alternative default probability measure based on CRSP and Compustat data. They claim that what they call Merton distance-to-default (Merton DD) models such as KMV do worse in predicting default than does a "naïve" model which "uses the functional form suggested by the Merton model but does not solve for an implied probability of default." This suggests that the Bharath and Shumway naïve (BS naïve) model might be useful in examining changes in risk surrounding mergers. In this appendix, we review what the BS naïve model looks like, what default probabilities it predicts, and discuss why we think it is not proper for the tests in this paper.

The BS naïve model estimates the distance to default making several assumptions. For example, they assume that the standard deviation of the debt value, σ_D is 0.05 + 0.25 * σ_E, where σ_E is the standard deviation of equity returns. This, plus assumptions that the market value of debt equals its face value and that expected equity returns equal past returns allow the authors to derive the naïve distance to default (equation (12) in BS (2008)):

$$\text{naïve DD} = \frac{\ln\left[\frac{E+F}{F}\right] + (r_{it-1} - 0.5 naive\ \sigma_V^2)T}{naive\ \sigma_V\ \sqrt{T}}$$

where E is the firm's equity value, F the face value of its debt, σ_V its total volatility, and T is the forecasting horizon. The probability of default (PD) is then estimated by assuming a normal distribution:

$$\text{naïve PD} = N(\text{-naïve DD})$$

where *N* is the normal cumulative distribution function.

BS (2008) estimate the model for all firms in CRSP and Compustat over the 1980-2003 time period. They find that the mean value of the probability of default using the naïve DD model is

8.95% with a standard deviation of 20.57% (see Table A-1). This is comparable to the 10.95% distance to default with a standard deviation of 23.32% that they find for the Merton model in their paper. However, MoodysKMV does not just use a standard Merton model. They augment it by using their proprietary data to go from a distance to default to a probability of default. Using data from 1996-2003 (to maximize the overlap with the data used by Bharath and Shumway), we find that the average EDF is 5.51% with a standard deviation of 7.18%. These values are much lower than those for the BS naïve model although we cannot reject the possibility that some of this difference may be due to different time periods.

Table A-1

	Mean	Standard deviation	Quantiles				
			Min.	0.25	Median	0.75	Max.
naïve PD	8.95	20.57	0.00	0.00	0.00	3.46	100.00
EDF	5.51	7.18	0.02	0.42	1.73	7.88	20.00

Source: Naïve PD from Table 1 in BS (2008); EDF from MoodysKMV.

What makes the BS naïve model particularly unsuitable for use in our paper, however, is the distribution of default probabilities that it implies (see Table A-1). The BS naïve model predicts that over 50% of firms have a 0% chance of default. MoodysKMV, on the other hand, estimates that only 2.3% of firms have the minimum EDF that they assign (0.02%) and only 9.2% have an EDF of 1% or less. To reinforce this, only 4.5% of firms with credit ratings have an AAA or AA rating during the sample period used in Bharath and Shumway.[28] Thus, it appears that while the BS naïve model may do well in ranking firms, it assigns far too many firms to an unrealistically low probability of default. Also, because it is so easy to earn an estimated default probability of zero, many mergers will have no estimated impact on default probability if we use the BS naïve model (see below).

Despite its limitations, we estimate the impact of mergers on default risk using the BS naïve model to estimate the probability of default. We follow the program included as an appendix to Bharath and Shumway (2004) to derive the naïve PD. There are 2,846 merger observations with

[28] Given that less than one-fourth of firms in Compustat have a credit rating and that firms with credit ratings tend to be safer than those without them, it is likely that well fewer than 4.5% of firms in Compustat are safe enough to qualify for an AAA or AA rating.

full data including a naïve PD. Comparing Table A-2 to Table A-1, the typical acquirer is riskier than the average firm in the Bharath and Shumway sample, but the rough distribution is similar. Using the naïve PD, mergers increase default risk by 6.96%, an economically and statistically significant amount. This is much larger than the average change in EDF. However, the median change in the naïve PD is zero, smaller than that using EDF. In large part, this is because the BS naïve model has a lot of zero default estimates *and* a lot of extremely high default estimates. For 18% of observations, the naïve PD does not change surrounding a merger (almost always starting and ending at zero) while for 16% of observations, estimated default risk changes by over 50 percentage points. This reinforces our belief as to the unsuitability of the BS naïve model for our analysis.

Table A-2

	Mean	Standard deviation	Quantiles				
			Min.	0.25	Median	0.75	Max.
naïve PD_{a-1}	12.73	26.43	0.00	0.00	0.02	6.92	100.00
Δ naïve PD	6.96	34.07	-99.97	-0.11	0.00	8.67	100.00

For the reasons outlined in this appendix, we believe that the BS naïve model proposed in Bharath and Shumway (2008) is not appropriate for testing how mergers affect default risk. Still, to the extent that we find significant changes in the probability of default surrounding mergers when using the BS naïve model, the changes are consistent with those we find using the EDFs from MoodysKMV.

Appendix 2. The power of diversification

To test whether mergers add risk rather than just transfer it from the target to the combined firm, we need to know by how much acquirer risk would rise simply as a result of acquiring a riskier target. Failure is inherently a tail event, so we need to focus on how the tail of the return distribution is affected by the merger. In this appendix, we describe two different approaches to this. The first, the one used in the main body of the paper, is to assume that returns are normally distributed. While not a perfectly accurate measure of stock returns, this assumption allows us to estimate failure probabilities explicitly, conditional on an estimated correlation between the returns of the target and the acquirer. The second approach is to use summary statistics to simulate mergers under different assumptions about the return distribution.

Under the assumption that returns are normally distributed, it is straightforward to find a pro forma risk for a merged firm. To do this, we use V_a, the market value for the acquirer at the end of the month prior to the merger announcement, and V_t, the same for the target. Given these market values and the EDFs from KMV, we back out the standard deviation of the acquirer's market value (σ_a) and the target's market value (σ_t) from our assumption that returns are distributed normally. We use daily data for the six months up to the end of the month prior to the merger announcement to estimate the correlation between the two returns (ρ). With this, we define *EDF pro forma* as the (one-year) probability of default for a firm with market value $V_a + V_t$ and variance of return $\sigma_a^2 + \sigma_t^2 + 2\,\rho\,\sigma_a\,\sigma_t$. Let Δ*EDF pro forma* = EDF_{c+6} – *EDF pro forma* measure the difference between the post-merger default risk and the estimated default risk of a combined target and acquirer prior to the merger.

Perhaps surprisingly given that targets are riskier than acquirers, the pro forma pre-merger default risk in an average merger is *lower* than the default risk of the stand-alone acquirer. For the subsample of 370 mergers where we have EDF and market data for both acquirers and targets, the mean acquirer EDF is 0.740 and the mean target EDF is 2.663. Because of asset diversification, however, the mean value of *EDF pro forma* is 0.595, implying that absent any actions taken by management, the default risk of the combined acquiring and target firms should be lower than the default risk of the acquiring firm. That is, even with the average default risk for the target being over three times as high as that of the acquirer, there are potentially significant

risk-reducing diversification benefits from a typical merger. Thus, diversification is very powerful. This may be because acquirers select targets with risks that have low correlation with those of the acquiring firm, something we find support for. On average, the correlation between the returns of the target and acquiring firms in our sample is a relatively small 0.137. The low average *EDF pro forma* suggests that the increase in risk surrounding a merger is not due to the relative risk of the target firm. Some risk is added in the merger process.

Our second approach to examining diversification is to simulate the impact on risk of various hypothetical mergers while varying our assumption regarding the underlying distribution of returns and return correlations. To approximately match the summary statistics, we base our simulations on the hypothetical acquisition of a target with an equity value of $47 million by an acquirer with equity value of $100 million. To match the characteristics of our data, we assume that the acquiring firm has an EDF of 0.740% and that the target firm has an EDF of 2.663%. Under the assumption of normally distributed equity returns, we can infer the target and acquirer's volatility from their respective EDF as outlined above. Following the merger, the combined firm's equity returns will be normally distributed, with a volatility dependent on the correlation between the acquirer and target returns pre-merger. The first column in Table A-3 reports that if the target and acquirer stock returns are uncorrelated, we would predict a post-merger EDF of 0.101%, approximately 86% *below* the original EDF of the acquirer, even though the target is three times as risky. As we increase the assumed level of correlation to 0.137, we find that diversification remains extremely strong, with the estimated post-merger default risk almost 75% below its initial level.

Of course, the distribution of acquirer stock returns is not likely to be perfectly described by a normal distribution. As we mention in Section I, KMV finds that 0.05% of the time, a firm seven standard deviations away from default defaults within one year. This implies a fatter-tailed distribution than the normal. We attempt to approximate this by noting that a t-distribution with 3 degrees of freedom has the characteristic that approximately 0.05% of its mass lies more than seven standard deviations below the mean. The second column in Table A-3 repeats our earlier simulation exercise under the assumption that equity returns for the target and acquirer have the same shape as the t(3) distribution, and in turn asks what the probability that the sum of these two

variables (appropriately scaled to reflect the relative size of the acquirer and target) results in the failure of the simulated merged firm. As the table reports, diversification is not as powerful when stock returns have fatter tails. Nevertheless, it remains strong. The simulation results indicate that when return correlations are around the typical level of 0.137, the default risk of the combined firm is estimated to be 0.572%, 23% below the acquirer's pre-merger level. This suggests that even with fatter tails in the return distribution, the power of diversification remains very strong.

Table A-3. Simulation results for the effects of asset diversification

This simulation assumes that a $100 million firm with an EDF of 0.740% acquires a $47 million target with an EDF of 2.663%. For each cell in the table, we find the EDF by taking 100,000 draws of the return from the merger over the next year and determining what proportion leave the merged firm in default.

	EDF pro forma	
Correlation	Assuming normal distribution	Assuming t(3) distribution
0	0.101%	0.409%
0.137	0.192%	0.572%
0.5	0.509%	0.867%

Table 1. Summary statistics on risk variables.

Summary statistics for the sample of firms with acquisitions from January 1994 – March 2006. EDF_{a-1} is the acquiring firm's EDF at the end of the month prior to the merger announcement. ΔEDF is the change in the acquiring firm's EDF from the end of the month prior to the merger announcement to the end of the month six months after the completion of the merger. $\Delta EDF\%$ is defined similarly for the percentage change in the acquiring firm's EDF. The credit rating is the S&P rating translated to a 1-19 scale. The rating is as of the last quarter end prior to the merger announcement. ΔCredit Rating (*X* months) is the change in the credit rating from the last quarter end prior to the merger announcement to the first quarter-end at least *X* months after the merger completion.

Variable	Obs.	Mean	Median	Std. Dev.
EDF_{a-1} *(%)*	3,604	1.370	0.590	2.057
ΔEDF (%)	3,604	0.520	0.060	1.531
$\Delta EDF\%$ (%)	3,604	0.936	0.250	1.856
Credit Rating	832	12.258	12.000	3.178
ΔCredit Rating (6 months)	832	0.106	0.000	0.849
ΔCredit Rating (12 months)	761	0.193	0.000	1.068

Table 2. Risk variables broken down by various subsamples

Summary statistics for the sample of firms with acquisitions from January 1994 – March 2006. EDF_{a-1} is the acquiring firm's EDF at the end of the month prior to the merger announcement. The standard deviation of the idiosyncratic component of the acquirer's stock return is estimated by taking the square root of the variance of the residuals from a market model estimated over the six month period ending at the end of the month prior to the merger announcement. The buy-and-hold return on the acquirer's stock is for the period from thirteen months prior to the announcement through the month prior to the announcement. The market-to-book ratio is measured as of the last quarterly balance sheet prior to the month of the merger announcement. Numbers listed under the various variables are means across the given subset of observations. P-values shown are for tests of equality of means for the various pairs of data.

	Obs.	EDF_{a-1}	*p-val*	ΔEDF	*p-val*	$\Delta EDF\%$	*p-val*
For mergers with target EDF data							
TARGET $EDF_{a-1} < EDF_{a-1}$	59	1.219	0.005	0.337	0.883	1.141	0.008
TARGET $EDF_{a-1} > EDF_{a-1}$	311	0.649		0.308		0.908	
Type of target							
Public	782	1.029	0.000	0.429	0.004	0.835	0.004
Private	1683	1.582		0.613		0.491	
Subsidiary	1139	1.290		0.445		1.169	
Financial leverage							
Decreases	1564	1.374	0.917	0.240	0.000	0.564	0.000
Increases	2040	1.367		0.734		1.221	
Fraction of the acquiring CEO's compensation that is derived from executive stock options							
Above median	597	0.818	0.011	0.328	0.007	0.884	0.209
Below median	597	0.629		0.167		0.756	
Standard deviation of the idiosyncratic component of the acquirer's stock return							
Above median	1802	2.242	0.000	0.861	0.000	1.059	0.000
Below median	1802	0.498		0.179		0.812	
Buy-and-hold return on the acquirer's stock prior to the announcement							
Net buy-and-hold return ≥ 0	1911	1.050	0.000	0.377	0.000	0.908	0.349
Net buy-and-hold return < 0	1693	1.731		0.681		0.966	
Acquirer market-to-book ratio							
Above median	1802	1.036	0.000	0.497	0.370	1.127	0.000
Below median	1802	1.704		0.543		0.744	

Table 3. Summary statistics.

Summary statistics for the sample of firms with acquisitions from January 1994 – March 2006. EDF_{a-1} is the acquiring firm's EDF at the end of the month prior to the merger announcement. *ΔEDF* is the change in the acquiring firm's EDF from the end of the month prior to the merger announcement to the end of the month six months after the completion of the merger. The *ΔEDF%* variables are defined similarly for the percentage change in the acquiring firm's EDF. *TARGET PUBLIC* is an indicator variable that takes the value 1 if and only if the target is publicly traded, while *TARGET SUB* and *TARGET PRIVATE* are defined analogously for targets that are subsidiaries and private firms, respectively. *OPTIONS* is defined as the fraction of the acquiring CEO's compensation that is derived from executive stock options. *VOL* is the standard deviation of the idiosyncratic component of the acquirer's stock return, estimated by taking the square root of the variance of the residuals from a market model estimated over the six month period ending at the end of the month prior to the merger announcement. *RUNUP* is the buy-and-hold return on the acquirer's stock for the period from thirteen months prior to the announcement through the month prior to the announcement. *MKT-TO-BOOK* is the ratio of the acquirer's market value of equity to the book value of equity as of the last quarterly balance sheet prior to the month of the merger announcement. *STOCK* is an indicator variable that takes the value 1 if and only if the acquisition is financed at least partially with stock. *CONGLOM* is an indicator variable that takes the value 1 if and only if the target and the acquirer are in different industries. *RATIO* is the ratio of the deal's value to the market value of the acquirer. *MKT VAL* is the natural log of the market value of the acquiring firm at the end of the month prior to the merger announcement. *CAR* is the cumulative abnormal return for the acquiring firm's stock from the day prior to the merger announcement through the day after the announcement.

Panel A. Full sample (3,604 observations).

Variable	Mean	Std. Dev.
EDF_{a-1} *(%)*	1.370	2.057
ΔEDF (%)	0.520	1.531
TARGET PUBLIC	0.201	0.391
TARGET SUB	0.324	0.455
TARGET PRIVATE	0.474	0.487
OPTIONS	-	-
VOL	0.034	0.016
RUNUP	0.138	0.566
MKT-TO-BOOK	2.972	2.319
STOCK	0.461	0.488
CONGLOM	0.209	0.397
RATIO	0.315	0.335
MKT VAL	5.784	1.760
CAR	0.020	0.076

Panel B. Execucomp sample (1,194 observations).

Variable	Mean	Std. Dev.
EDF_{a-1} *(%)*	0.724	1.287
ΔEDF (%)	0.247	1.032
TARGET PUBLIC	0.331	0.459
TARGET SUB	0.336	0.460
TARGET PRIVATE	0.332	0.460
OPTIONS	0.365	0.292
VOL	0.026	0.012
RUNUP	0.099	0.471
MKT-TO-BOOK	3.071	2.218
STOCK	0.416	0.481
CONGLOM	0.169	0.363
RATIO	0.283	0.307
MKT VAL	7.151	1.432
CAR	0.009	0.068

Table 4. Regressions on the determinants of the change in risk.

The dependent variable in the first three columns is *ΔEDF*, defined as the change in the acquiring firm's EDF from the end of the month prior to the merger announcement to the end of the month six months after the completion of the merger. In column 4, the dependent variable is *ΔEDF%*, defined similarly for the percentage change in the acquiring firm's EDF. *TARGET PUBLIC* is an indicator variable that takes the value 1 if and only if the target is publicly traded, while *TARGET SUB* is defined analogously for targets that are subsidiaries. *VOL* is the standard deviation of the idiosyncratic component of the acquirer's stock return, estimated by taking the square root of the variance of the residuals from a market model estimated over the six month period ending at the end of the month prior to the merger announcement. *RUNUP* is the buy-and-hold return on the acquirer's stock for the period from thirteen months prior to the announcement through the month prior to the announcement. *RUNUP TOP 10* is an indicator variable that takes the value 1 if a firm's *RUNUP* is in the top 10% of all firms' *RUNUPs*. *MKT-TO-BOOK* is the ratio of the acquirer's market value of equity to the book value of equity as of the last quarterly balance sheet prior to the month of the merger announcement. *STOCK* is an indicator variable that takes the value 1 if and only if the acquisition is financed at least partially with stock. *CONGLOM* is an indicator variable that takes the value 1 if and only if the target and the acquirer are in different industries. *RATIO* is the ratio of the deal's value to the market value of the acquirer. *MKT VAL* is the natural log of the market value of the acquiring firm at the end of the month prior to the merger announcement. *CAR* is the cumulative abnormal return for the acquiring firm's stock from the day prior to the merger announcement through the day after the announcement. *CAR RESID* is the estimated residual from the regression of *CAR* on *RETURN INTERIM*, defined as the buy-and-hold return for an acquirer's stock between the end of the month prior to its merger announcement to the end of the month six months after the merger is effective. *DIST FROM DESIRED RISK* is defined as the residual from a regression of acquirer *EDF/RATING* on balance sheet determinants of target risk level. All the regressions have 3,604 observations and include year, industry, and initial risk-level dummies. P-values for robust standard errors with firm cluster effects are in parentheses.

Table 4 (cont.)

	Dependent variable					
	ΔEDF	*ΔEDF*	*ΔEDF*	*ΔEDF%*	*ΔEDF*	*ΔEDF%*
TARGET PUBLIC	-0.116	-0.067	-0.055	0.001	-0.057	-0.002
	(0.124)	(0.372)	(0.467)	(0.987)	(0.453)	(0.981)
TARGET SUB	-0.067	-0.070	-0.073	-0.070	-0.069	-0.061
	(0.251)	(0.235)	(0.209)	(0.287)	(0.237)	(0.353)
VOL	27.387	26.993	26.100	32.805	25.210***	30.994***
	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)	(0.000)
RUNUP	-0.187	-0.224	-0.210	-0.066	-0.295***	-0.240***
	(0.004)***	(0.001)***	(0.001)***	(0.342)	(0.000)	(0.006)
RUNUP top 10% DUMMY					0.231*	0.470***
					(0.061)	(0.001)
MKT-TO-BOOK	0.018	0.015	0.041	0.074	0.041**	0.073***
	(0.233)	(0.340)	(0.025)**	(0.000)***	(0.027)	(0.000)
STOCK	-0.121	-0.105	-0.120	0.056	-0.118**	-0.066
	(0.037)**	(0.070)*	(0.038)**	(0.425)	(0.040)	(0.302)
CONGLOM	0.066	0.068	0.075	0.565	0.075	0.056
	(0.330)	(0.318)	(0.270)	(0.000)***	(0.271)	(0.426)
RATIO	0.312	0.287	0.288	-0.077	0.285***	0.560***
	(0.001)***	(0.002)***	(0.002)***	(0.003)***	(0.002)	(0.000)
MKT VAL	-0.056	-0.051	-0.049	-0.070	-0.049**	-0.079***
	(0.010)***	(0.017)**	(0.023)**	(0.277)	(0.021)	(0.003)
CAR	-1.347					
	(0.001)***					
CAR RESID		0.271	0.242	0.109	0.240	0.105
		(0.510)	(0.555)	(0.805)	(0.558)	(0.811)
DISTANCE FROM DESIRED RISK			-0.165	-0.251	-0.165***	-0.251***
			(0.003)***	(0.000)***	(0.003)	(0.000)
Observations	3604	3604	3604	3604	3604	3604
R-squared	0.171	0.167	0.172	0.258	0.174	0.261

Robust p-values in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 5. Regressions on the determinants of the change in risk – Execucomp sample.

The dependent variable in the first three columns is *ΔEDF*, defined as the change in the acquiring firm's EDF from the end of the month prior to the merger announcement to the end of the month six months after the completion of the merger. In column 4, the dependent variable is *ΔEDF%*, defined similarly for the percentage change in the acquiring firm's EDF. *TARGET PUBLIC* is an indicator variable that takes the value 1 if and only if the target is publicly traded, while *TARGET SUB* is defined analogously for targets that are subsidiaries. *VOL* is the standard deviation of the idiosyncratic component of the acquirer's stock return, estimated by taking the square root of the variance of the residuals from a market model estimated over the six month period ending at the end of the month prior to the merger announcement. *RUNUP* is the buy-and-hold return on the acquirer's stock for the period from thirteen months prior to the announcement through the month prior to the announcement. *MKT-TO-BOOK* is the ratio of the acquirer's market value of equity to the book value of equity as of the last quarterly balance sheet prior to the month of the merger announcement. *STOCK* is an indicator variable that takes the value 1 if and only if the acquisition is financed at least partially with stock. *CONGLOM* is an indicator variable that takes the value 1 if and only if the target and the acquirer are in different industries. *RATIO* is the ratio of the deal's value to the market value of the acquirer. *MKT VAL* is the natural log of the market value of the acquiring firm at the end of the month prior to the merger announcement. *CAR* is the cumulative abnormal return for the acquiring firm's stock from the day prior to the merger announcement through the day after the announcement. *CAR RESID* is the estimated residual from the regression of *CAR* on *RETURN INTERIM*, defined as the buy-and-hold return for an acquirer's stock between the end of the month prior to its merger announcement to the end of the month six months after the merger is effective. *DIST FROM DESIRED RISK* is defined as the residual from a regression of acquirer *EDF/RATING* on balance sheet determinants of target risk level. *EXECUCOMP* SAMPLE is an indicator variable that takes the value 1 if and only if the acquirer is in the Execucomp data for the year prior to the merger announcement. OPTIONS is defined as the fraction of the acquiring CEO's compensation that is derived from executive stock options if *EXECUCOMP SAMPLE* equals 1 and is zero otherwise. All the regressions include year, industry, and initial risk-level dummies. P-values for robust standard errors with firm cluster effects are in parentheses.

	Dependent variable			
	ΔEDF	*ΔEDF*	*ΔEDF*	*ΔEDF%*
TARGET PUBLIC	-0.055	-0.063	0.039	-0.006
	(0.467)	(0.408)	(0.642)	(0.950)
TARGET SUB	-0.073	-0.071	-0.013	-0.056
	(0.209)	(0.227)	(0.863)	(0.396)
VOL	26.100	25.868	25.850	30.152
	(0.000)***	(0.000)***	(0.000)***	(0.000)***
RUNUP	-0.210	-0.205	-0.224	-0.242
	(0.001)***	(0.001)***	(0.006)***	(0.006)***
MARKET-TO-BOOK	0.041	0.040	0.048	0.067
	(0.025)**	(0.033)**	(0.049)**	(0.001)***
STOCK	-0.120	-0.121	-0.100	0.055
	(0.038)**	(0.036)**	(0.170)	(0.432)
CONGLOM	0.075	0.075	0.057	0.559
	(0.270)	(0.267)	(0.500)	(0.000)***
RATIO	0.288	0.290	0.328	-0.058
	(0.002)***	(0.002)***	(0.008)***	(0.045)**
MKT VAL	-0.049	-0.052	-0.041	-0.069
	(0.023)**	(0.031)**	(0.154)	(0.280)
CAR RESID	0.242	0.251	0.540	0.106
	(0.555)	(0.541)	(0.403)	(0.810)
DISTANCE FROM DESIRED RISK	-0.165	-0.166	-0.244	-0.251
	(0.003)***	(0.003)***	(0.011)**	(0.000)***
EXECUCOMP SAMPLE		-0.116		0.466
		(0.042)**		(0.002)***
OPTIONS		0.304	0.307	0.455
		(0.011)**	(0.011)**	(0.006)***
Observations	3604	3604	1194	3604
R-squared	0.172	0.173	0.220	0.263

Robust p-values in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%