No News is News: Do Markets Underreact to Nothing?

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Abstract

As illustrated in the tale of "the dog that did not bark," the absence of news and the pure passage of time often contain important information. We test how markets react to "no news" using the empirical context of mergers. Following the initial merger announcement, uncertainty relating to merger completion can take several months to a year to be resolved. We find that hazard rates of merger completion vary strongly over time after the merger announcement, implying that the pure passage of time (i.e., no news) can predict merger completion. If markets are rational, prices should correctly incorporate this information. When we examine target return patterns, we find that the aggregate merger completion hazard rates are positively correlated with target returns. This is consistent with a bounded rationality model in which the agents underreact to the passage of time – if agents are fully rational, aggregate hazard rates should not predict returns. We present a variety of tests showing that our findings are not driven by changes in risk over the event life of the merger. A strategy that buys deals during event weeks when merger completion hazard rates are high on aggregate significantly outperforms a strategy that holds deals when completion hazard rates are low. In addition, we observe no significant variation in risk exposures over the event life of each merger.

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1 Introduction

"The dog did nothing in the night-time ... that was the curious incident."
- Sir Arthur Conan Doyle

The absence of news reports and the pure passage of time often contain important information. For example, a citizen who lives through a sustained period without terrorist attacks should update positively on whether the government is doing a good job keeping terrorists at bay. A manager who observes that an employee has executed a difficult task without error should update positively on the employee's quality.

"No news" is also news in many financial contexts. For example, if a firm does not lay off workers or declare bankruptcy after a macroeconomic shock, investors should update positively on the firm's underlying strength. On the other hand, if an otherwise healthy firm repeatedly fails to announce new investment projects, rational investors may be justified in updating negatively on the growth prospects of the firm. Finally, investment return patterns that seldom display news-worthy variation can reveal information about the underlying investment decisions; for example, too consistent a return pattern may reveal that the returns are doctored, as in the case of Bernie Madoff's investment fund.

Rational agents should perform Bayesian updating on no news and the passage of time. In efficient financial markets with rational investors, the passage of time can lead to trading and price movements even in the absence of news. Alternatively, agents may be boundedly rational and imperfectly update on no news. Agents may suffer from limited attention (Tversky and Kahneman, 1973) and underreact to the absence of news, which by definition is less salient and vivid than the events covered by news stories. In addition, agents may suffer from the base rate fallacy (Bar-Hillel, 1980) and overweight individual characteristics relative to aggregate information such as the predictive power of the passage of time. Understanding how agents process the absence of news is important, as underreaction to no news can lead to the misallocation of resources, which may be particularly distortionary because no news tends to be slow-moving and persistent.

In this paper, we explore how markets react to no news. The main empirical challenge lies in the construction of a counterfactual: how *should* agents behave *if* they were to update correctly on no news? We focus our attention on a financial context that allows for the construction of such a counterfactual: mergers.

Mergers offer a convenient empirical setting for several reasons. First, each merger has a clear starting point: the announcement of the intention to merge. Second, returns of merger investment strategies depend heavily on a well-defined and stochastic ending point: the merger either completes, or the acquirer withdraws. Between these two events, there exists an interim period of several months to a year during which little or scattered news is released about the probability of completion. We show empirically that the pure passage of time, i.e. no news, during this interim period contains information about whether the deal will ultimately complete. We can then compute how prices should move in the cases of full rationality and underreaction to no news.

Using a sample of over 5000 mergers from 1963 to 2009, we begin by estimating the hazard rate of merger completion, defined as the probability that a merger will complete in week n conditional on it not completing or withdrawing prior to week n. For no news to be news, i.e., the passage of time to contain information, it must be the case that the hazard rate of completion is non-constant over the event life of a merger.

Our empirical analysis reveals that hazard rates of completion do indeed strongly vary over event time. This holds both when pooling together all mergers in our sample and after grouping mergers into two major categories: cash mergers and equity-financed mergers. For example, for equity-financed mergers, hazard rates of completion start from zero in the first weeks after announcement to a peak of eight percent per week around week 23, and decline to zero one year after announcement. In contrast, hazard rates of withdrawal are essentially flat.

What does this time variation imply for stock prices? We develop a simple model that links movements in the target's price to market beliefs about event-time variation in hazard rates in order to demonstrate the main intuition. If agents correctly update on the passage of time, and if risk does not change over the event life of mergers, then mean weekly returns[1] should be constant: they should not vary systematically with the passage of time and they

[1] For cash-financed mergers, the relevant return is the return from holding the target. For equity-financed mergers, the relevant return is that from a strategy in which one takes a long position in the target and a short position in the acquirer.

should not be predicted by aggregate changes in hazard rates.

Importantly, this prediction holds even if investors observe news events prior to formal merger resolution: if investors are rational and update on intermediate bits of news as well as the passage of time, that should make the passage of time even less predictive of returns.

However, if agents underreact to the passage of time, they will behave as though they believe that the underlying hazard rate of completion does not change over time. This implies that agents will tend to *under*estimate the completion hazard rate when hazard rates are high (around the peak in week 23) and *over*estimate it when hazard rates have fallen.

Market underreaction to no news implies that mean returns should be high when hazard rates are high (since markets underestimate merger completion probability and receive positive surprises on average) and low when hazard rates are low (since the market overestimates merger completion probability and are disappointed on average). In other words, hazard rates and mean returns should be positively correlated. This is in fact what we observe in the data: mean returns are significantly non-constant over the event life of a merger and the pattern in returns is aligned with movements in aggregate hazard rates. We find a significant positive relationship between aggregate hazard rates and merger. A simple model calibration suggests that the market incorporates only about one-half of the time-variation in hazard rates.

We then test a sharper implication of our pricing model using the timing of mispricing. Our model – using only information in estimated aggregate hazard rates – tells us in which event weeks we should expect to earn *higher-than-average* or *lower-than-average* returns. We test whether a trading strategy that buys deals when the model-predicted returns are higher than average (which corresponds to *high-hazard* weeks) delivers a higher alpha than a strategy that holds deals in the remaining weeks (*low-hazard* weeks), as well as a buy-and-hold strategy that holds deals for their entire event life.

Our *high-hazard* trading strategy delivers a significant monthly alpha (relative to the three Fama and French factors) of around 63bp for cash deals and 131bp for equity deals. This is significantly higher than the -3bp and 32bp respectively of strategies that buy deals in the *low-hazard* weeks, and is also higher than the 39bp and 109bp respectively of the buy-and-hold strategy.

These results support the behavioral hypothesis that markets underreact to no news, and therefore returns tend to be high when hazard rates are high and vice versa. However, an alternative explanation for our findings is that agents are fully rational, but risk and/or risk premia vary over the event life of a merger and are correlated with changes in the hazard rate. We conduct a variety of tests to show that our results cannot explained by changes in risk.

We begin by noting that the positive correlation between predicted hazard rates and returns is a phenomenon measured over the event life of the merger, and therefore cannot be explained by changes in risk or risk premia over calendar time.[2] Next, we show that risk does not vary significantly over the event life of a merger and is not correlated with hazard rates. In general, our strategies have very low exposure to the three Fama and French factors, with all betas under 0.3. We also show that *high-hazard* event weeks do not have, on average, higher betas then *low-hazard* weeks. Finally, we compute event-week-specific betas, and test whether they change significantly in event time. Over the course of the calendar period during in which we execute our trading strategy, we observe many mergers in each stage of deal life. We can then ask what the risk properties are for strategies that only enter deals *during each event week separately.* Our analysis shows that the exposures to the three Fama-French factors do not change observably in event time, and if anything are weakly negatively correlated with hazard rates.

Finally, we show that the positive relationship between hazard rates and returns cannot be explained by high exposure to downside risk which varies in event time. In general, as with all merger arbitrage strategies, our strategy is more risky in down markets than in regular markets (the market beta increases from 0.1 to 0.4). However, mean strategy returns actually decline by less than market returns during major downturns. Moreover, we show empirically that downside beta does not vary significantly over the event life and is not correlated with hazard rates. Therefore, while downside risk is a potential contributor to the positive returns in a buy-and-hold merger arbitrage strategy, downside risk cannot explain why returns covary with hazard rates over the event life of a merger.

[2]Because mergers occur in waves, we may be concerned that event time is correlated with calendar time, and therefore, changes in risk or risk premia over calendar time may matter. However, when regressing returns on hazard rates, the results hold strongly even when we control for calendar time (year x month) fixed effects, which removes all calendar time variation in risk and risk premia.

We conclude that changes in risk and risk premia are unlikely to drive the relationship between hazard rates and returns. Rather, the empirical evidence supports the hypothesis that markets fail to incorporate all information contained in the passage of time while waiting for merger resolution. We also find evidence consistent with the presence of sophisticated investors who correctly update on no news: the relation between returns and hazards is twice as strong for the smaller half of deals than for the larger half of deals. This suggests a limits to arbitrage story in which sophisticated investors are unable to fully arbitrage away mispricing due to transaction costs, which may be higher for smaller deals.

To the best of our knowledge, this is the first paper to empirically investigate market underreaction to no news. However, our findings build upon and complement related findings in behavioral finance. For example, Da, Gurun and Warachka (2012) show that markets underreact to the slow release of news. Corwin and Coughenour (2008) and Barber and Odean (2008) show that investors focus on familiar or attention-grabbing stocks while Hirshleifer, Lim and Teoh (2009) find that investors underreact to relevant news when flooded with other news events. Overall, the existing literature argues that investors exhibit limited attention when sifting through a set of news stories. In contrast, this paper shows that investors *also* underreact to the absence of news, which itself can contain valuable information.

2 Data

We perform our analysis using a combination of two data sources. The first data source, generously shared by Mark Mitchell and Todd Pulvino (MP), covers mergers starting in the 1960s and up to 2010. It is an updated version of the data used in Mitchell and Pulvino (2001). The other data source is Thomson One (TO), and covers merger activity from 1985 to 2010. Because MP covers a much longer time series while TO offers more comprehensive coverage over recent years, we combine the two datasets as follows: we use the MP data up to 1995, and the TO dataset afterwards. The exact year of the split is determined by comparing the relative coverage of the two datasets in each year, and our results are robust to using only MP or only TO data.

We define the initial takeover premium for cash deals as the ratio of the initial offer price at deal announcement to the price of the target two days before deal announcement. For equity-financed deals, the takeover premium is defined as $R * P^A_{t=-2}/P^T_{t=-2}$, where R is the exchange ratio, defined as the number of acquirer shares offered for each share of the target.

We apply the following filters to our initial sample of mergers.

1. The merger is all cash financed or all equity financed. We exclude hybrid forms of financing or deals with contingency terms (e.g., collar agreements) because they are more difficult to price using the available data on equity prices. For equity-financed deals, we require that there exists data on the exchange ratio for the deal, e.g., 0.5 shares of the acquirer will be paid for each share of the target.

2. The merger takes the form of a simple one-step merger without a known expiration date or anticipated date of completion. We exclude tender offers, which have known expiration dates, because the information content of the passage of time near and beyond the expiration date is likely to be obvious to market participants.

3. For cash financed mergers, equity price data is available for the target from CRSP. For equity financed mergers, equity price data for both the target and acquirer is available from CRSP.

4. We exclude deals for which the typical hazard rates of completion or withdrawal are less applicable. First, we exclude deals that compete with a previous bid for the same target that was announced within the past three years because competing bids are relatively more likely to withdraw and follow more deal-specific heterogeneity in timing. Second, we exclude deals in which the initial takeover premium is less than one. As we execute our trading strategy (see Section 6.1), we also exit out of a deal if the target price rises above the acquirer offer price (or the imputed offer price, defined as the exchange ratio multiplied by the acquirer stock price, in the case of an equity-financed merger), because these represent cases in which the market expects either a competing offer or a favorable revision of deal terms. In these cases, deal completion is less likely to be the primary form of uncertainty.

After applying these filters, we are left with 3385 cash financed deals and 1955 equity financed deals, which are summarized in Table 1. 70 percent of cash financed deals complete with a

	Cash Mergers			Equity Mergers		
	Mean	Median	Stdev	Mean	Median	Stdev
Number of deals	3385			1955		
Time to completion	99.2	83.0	60.8	110.1	97.0	57.7
Time to withdrawal	66.0	40.0	85.7	66.0	44.0	94.0
% Completed	70.5			76.4		
% Withdrawn	22.2			18.8		
% Pending	7.3			4.8		
Premium	1.33	1.26	0.40	1.33	1.23	1.22
Size 1960-1979	54.4	19.3	959.7	67.9	27.5	146.4
Size 1980s	228.5	50.8	762.9	241.2	51.4	742.3
Size 1990s	269.8	70.1	673.7	687.4	144.0	2886.0
Size 2000s	1017.8	191.8	3157.1	1147.1	166.0	4344.5

Table 1: Summary Statistics

median time to completion of 83 days. 76 percent of equity financed deals complete with a median time to completion 97 days.

3 Hazard Rates

Updating on the passage of time with respect to an uncertain future event (e.g., merger completion) should take place only if the probability that the event occurs (the hazard rate) changes over time. If the hazard rate is constant over time, the pure passage of time, i.e., no news, contains no useful information. The first step of our analysis is to establish that the hazard rate of merger completion is indeed non-constant over event time, and as a consequence we should expect updating on no news by rational agents.

Let $S(t)$ be the probability that the merger survives up to event time t, where t refers to the number of weeks after the merger announcement. Let $h(t)$ be the hazard rate of completion at time t, i.e., the probability that the merger completes during period t conditional on surviving up to t. We also estimate a separate hazard rate of withdrawal $w(t)$, although we will later show that this hazard rate remains roughly constant over time.

We use the standard Kaplan-Meyer estimator, which constructs the hazard rates of completion (withdrawal) as the fraction of deals that complete (fail) during each period t among those that have survived until time t. The Kaplan-Meyer estimator assumes that all merger completion and withdrawal events are drawn from the *same* underlying distribution, and provides an estimate of such a distribution at each point in event time. In reality, it is reasonable to think that deal completions and withdrawals might follow different hazard processes depending on observable or unobservable characteristics of each deal. We explicitly account for one such major source of heterogeneity: the financing of the deal. A large literature has explored the differences between cash and equity financed deals, and we allow the two to have different hazard rates functions of completion and withdrawal. Another dimension of heterogeneity is whether the deal is a tender offer or not. As noted previously, we exclude tender offers from our analysis because they tend to complete quickly and have known expiration dates. Finally, hazard rates could vary along other dimensions, which we do not explicitly account for. To the extent that ignoring them affects the observed relation between hazard and returns, it should work *against* the behavioral hypothesis's predicted positive relationship between hazard rates and returns, and would therefore represent a bias against our results.

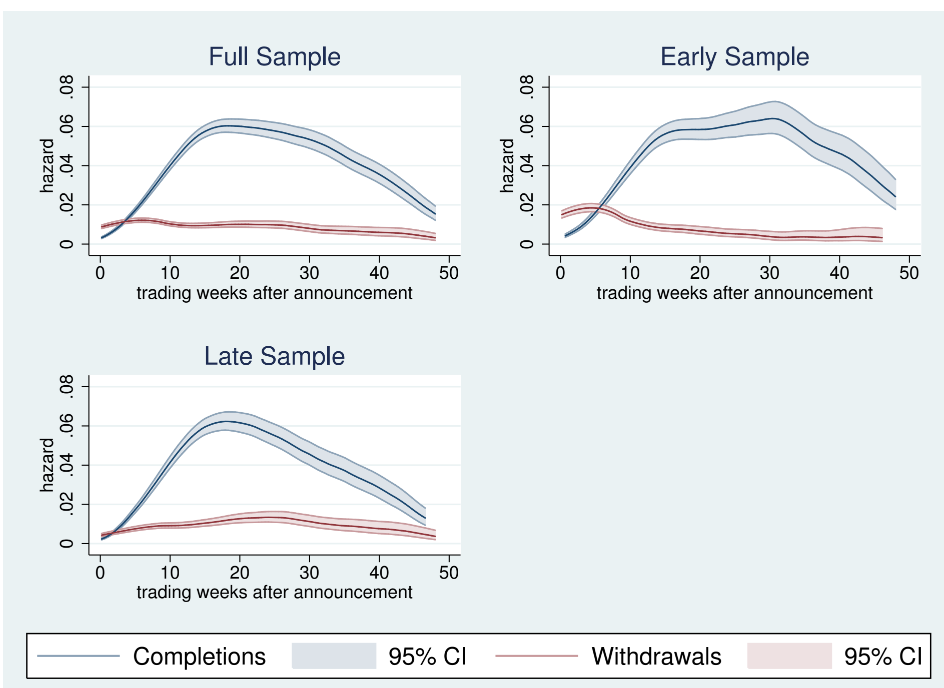

Figure 1: Hazard Rates: Cash Mergers

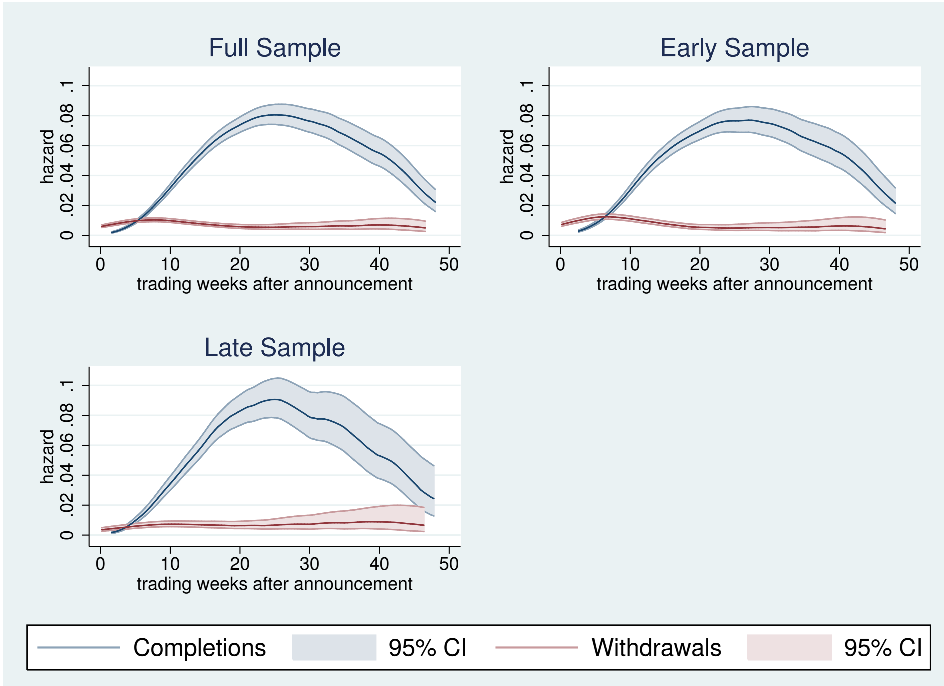

Figure 2: Hazard Rates: Equity Mergers

Figures 1 and 2 show the estimated hazard rates of completion and withdrawal for cash and for equity deals. The figures report estimates computed using the full sample of mergers (1963-2010), and separately over the early and late parts of the sample (1963-1990 and 1991-2010 respectively).

Three main results emerge from these figures. First, the hazard rates of completion are strongly non-constant: for cash deals, they start at around zero during the first weeks, then rise to about five percent per week around week 15, and gradually decline to zero by the end of the first year after announcement. A similar pattern is observed for equity deals, for which the hazard rate reaches 9 percent at the peak. Second, hazard rates of withdrawal are essentially constant for both cash and for equity deals. Third, hazard rate patterns estimated using the early and late calendar time samples are similar, suggesting that hazard rate patterns have not changed significantly over the past several decades.

Armed with the result that hazard rates of completion vary significantly over the event lives of mergers, we now study the implications for returns. The next section presents a simple model that offers the main intuition.

4 A Simple Model

To understand what time variation in hazards implies for returns when markets perfectly or imperfectly update on no news, consider the following pricing model for the returns of the *target* of a cash merger after the announcement of the intention to merge.

Let t represent the number of weeks after merger announcement, as measured in event time. Let $\hat{P}(t)$ be the price of the target's shares after the announcement has been made, but before the deal has completed or withdrawn. Even in the absence of specific news about the deal, $\hat{P}(t)$ can change over time if investors use the passage of time to update on the probability that the deal will complete. If at any point the deal completes, the value of the target jumps to P_C, the amount of cash per share promised to the target's equity holders. If at any point the deal is withdrawn, the price jumps to $P_0(t)$, where $P_0(t)$ is some latent process. We model $P_0(t)$ as follows:

$$dP_0(t) = \mu P_0(t)dt + \sigma P_0(t)dZ(t)$$

where $Z(t)$ is a a standard Brownian motion. We assume that there is an end time, T, such that any deal that does not complete by time T is assumed to never complete (in accordance with the empirical evidence that shows that hazard rates of completion fall to zero after approximately one year).

If the merger has not completed or withdrawn time t, the price of the target $\hat{P}(t)$ is determined as follows:

$$\begin{aligned}\hat{P}(t) &= E_t^*\{\textstyle\int_t^T e^{-r(z-t)}e^{-\int_t^z[\hat{h}(k)+\hat{w}(k)]dk}\hat{h}(z)P_C dz \\ &+ \textstyle\int_t^T e^{-r(z-t)}e^{-\int_t^z[\hat{h}(k)+\hat{w}(k)]dk}\hat{w}(z)P_0(z)dz \\ &+ e^{-r(T-t)}e^{-\int_t^T[\hat{h}(k)+\hat{w}(k)]dk}P_0(T)\}\end{aligned}$$

where E^* represents the risk-neutral expectation and $\hat{h}$ and $\hat{w}$ are risk-neutral hazard rates.

To understand the intuition of the model, assume that all risk is idiosyncratic and the market believes that all risk is idiosyncratic. This means that we can interpret $\hat{h}$ and $\hat{w}$ as *market beliefs about the actual hazard rates*, as opposed to the risk-neutral hazard rates that also reflect the risk attitude of the market (we postpone a thorough discussion of risk to a later section).

Under these modeling assumptions, it is easy to show that the expected one-period return at time t, $E[ret_t]$, can be decomposed as follows:

$$\begin{aligned} E\left[ret_t\right] &= rdt \\ &+ \left(\frac{P_C}{\hat{P}(t)} - 1\right)\left[h(t) - \hat{h}(t)\right]dt \\ &+ \left(\frac{P_0(t)}{\hat{P}(t)} - 1\right)\left[w(t) - \hat{w}(t)\right]dt \end{aligned}$$

where h and w are the *true* hazard rates (as opposed to the market beliefs represented by $\hat{h}$ and $\hat{w}$). Note that we have

$$\left(\frac{P_C}{\hat{P}(t)} - 1\right) > 0$$

$$\left(\frac{P_0(t)}{\hat{P}(t)} - 1\right) < 0$$

The model generates simple testable predictions concerning the relationship between hazard rates and mean returns at each event time t. First, if markets have correct beliefs about hazard rates ($h(t) = \hat{h(t)}$, $w(t) = \hat{w(t)}$), the mean target return will always equal the risk free rate r (since all risk is idiosyncratic). Second, if the market *under*estimates completion hazard rates, mean returns will be higher than the risk free rate r. This occurs because the markets, underestimating the probability of completion, will receive positive surprises on average, generating abnormally high returns. Finally, if markets *over*estimate the completion probability ($\hat{h} > h$), the target's stock will be *over*valued at time t and experience a return lower than the risk-free rate. Note that returns in each period depend only on different between beliefs and true hazard rates in that that period and not on future differences in beliefs and true hazard rates.

These predictions directly map to the behavioral hypothesis of market underreaction to no news. Suppose that markets fail to use the passage of time to update on changes to the hazard rate, but have correct beliefs on average over the event life of a merger. In other words, the market believes that $\hat{h}(t) = \hat{h}$ and $\hat{w}(t) = \hat{w}$, where $\hat{h}$ and $\hat{w}$ represent

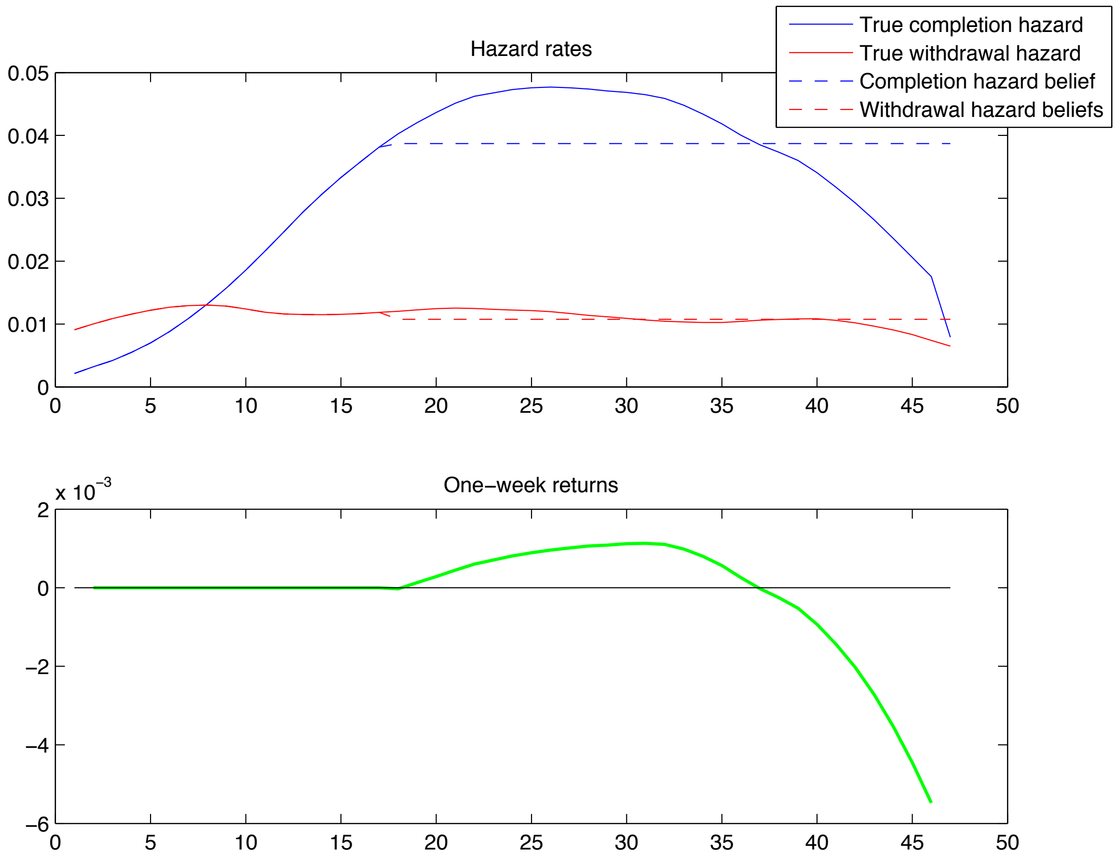

Figure 3: Model Predictions of Returns Given Beliefs

the average of the *true* hazard rates. This implies that the market will have approximately correct beliefs about the hazard rate of withdrawal because $w(t)$ is approximately constant over time. However, the market will underestimate the completion hazard rate during event weeks in which the true hazard rate is high. During these times, the model predicts that we should observe particularly high returns for the target's stock. In contrast, in event periods in which the completion hazard rate is particularly low, markets, by underreacting to this variation, will *over*estimate the hazard rate, and the model tells us we should expect to see particularly low returns for the target. In other words, underreaction to no news implies that mean excess returns should be positively correlated with true hazard rates.

Figure 3 shows an example of how relationship between hazards and returns varies depending on whether beliefs are correct. The top panel shows the completion and withdrawals hazard rates (solid lines), estimated for cash deals. It also plots a sample set of beliefs in which the market holds correct beliefs about hazard rates for the first several weeks after deal announcement (the dotted line and the solid lines coincide). After a certain number of weeks, and up to a year after announcement, agents fail to use the passage of time to update on change in the hazard rate. The beliefs about the completion hazard rate are *constant but correct on average*. As a consequence, between weeks 16 and 36 markets *under*estimate the true completion hazard rate, while after week 36 markets *over*estimate the hazard rate. By the end of the year after the announcement, markets correctly understand that the deal will never complete.

The lower panel of Figure 3 shows the model predictions for average returns in each event week, assuming that the deal has not yet completed or withdrawn. During event periods in which beliefs are correct, mean excess returns are zero. When markets underreact to no news but have correct beliefs on average about hazard rates, the return curve follows the shape of the hazard rate of completion: returns are positively correlated with hazard rates.

These predictions extend to a model in which merger returns contain risk that is systematic and in which risk premia are allowed to be non-constant in *calendar* time. As long as risk and risk premia does not vary on average over event time, rational updating on no news implies that merger returns should be constant over the event life of the merger (although returns may exceed the risk free rate). Underreaction to no news then implies a *positive* relationship between between hazard rates and returns. These predictions also extend to a model of returns for equity-financed deals: returns for these deals are those from a portfolio in which investors long the target and short the acquirer. Finally, these predictions hold if agents also hold incorrect beliefs about the average completion rate over the merger's event life. As long as hazard rate beliefs exhibit flatter variation with respect to event time than true hazard rates, the model predicts a positive relationship between hazard rates and mean returns.

This simple model is meant to illustrate the behavioral hypothesis's predictions and may depart from reality in two ways. First, the market may observe news (e.g., deal-specific news about a competing bidder) prior to merger resolution, which can lead to jumps in $\hat{P}(t)$. The release of deal-specific news is a bias against the behavioral prediction that hazard rates should predict returns. If investors are rational and update on intermediate bits of news as well as the passage of time, that should make the passage of time even less predictive of returns. Second, we focus on time-varying hazard rates as one reason why the passage of time is informative of deal completion. It's possible that other real events (e.g., expected merger synergies) vary systematically with hazard rates over the event life of mergers and it is this variation in other real events that the market underreacts to rather than the variation in hazard rates per se. This behavior would still be consistent with the behavioral hypothesis – investors are systematically underreacting to the passage of time if hazard rates (and the real events correlated with hazard rates) predict returns.

5 Returns and Hazards

Our model predicts that underreaction to no news will lead to a positive relationship aggregate hazard rates of completion and mean returns. We start by plotting the series of hazard and returns in event time for cash and equity-financed mergers.

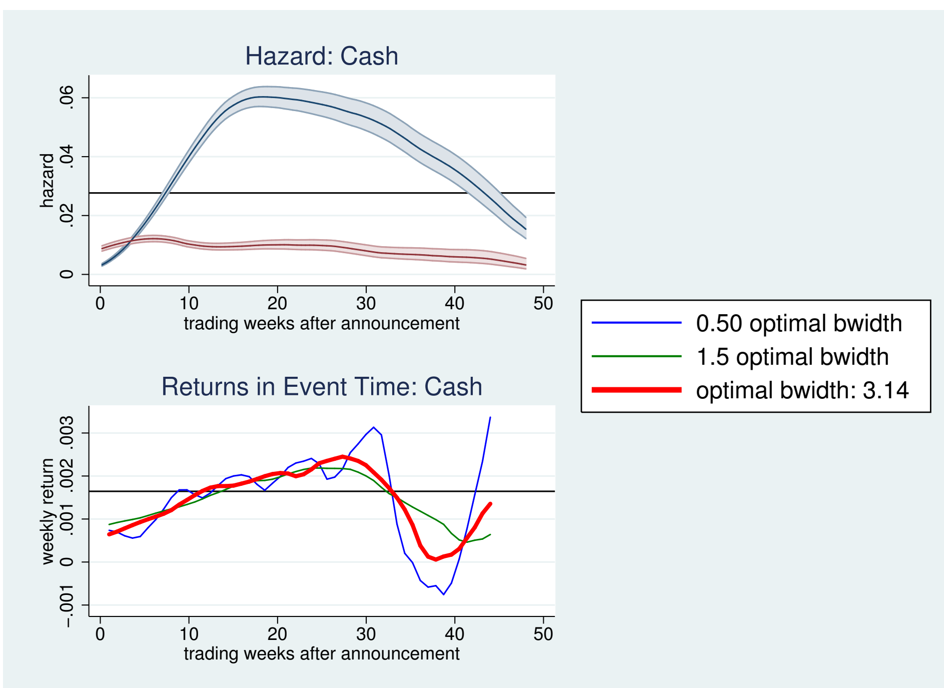

Figure 4: Hazards vs. Returns: Cash Mergers

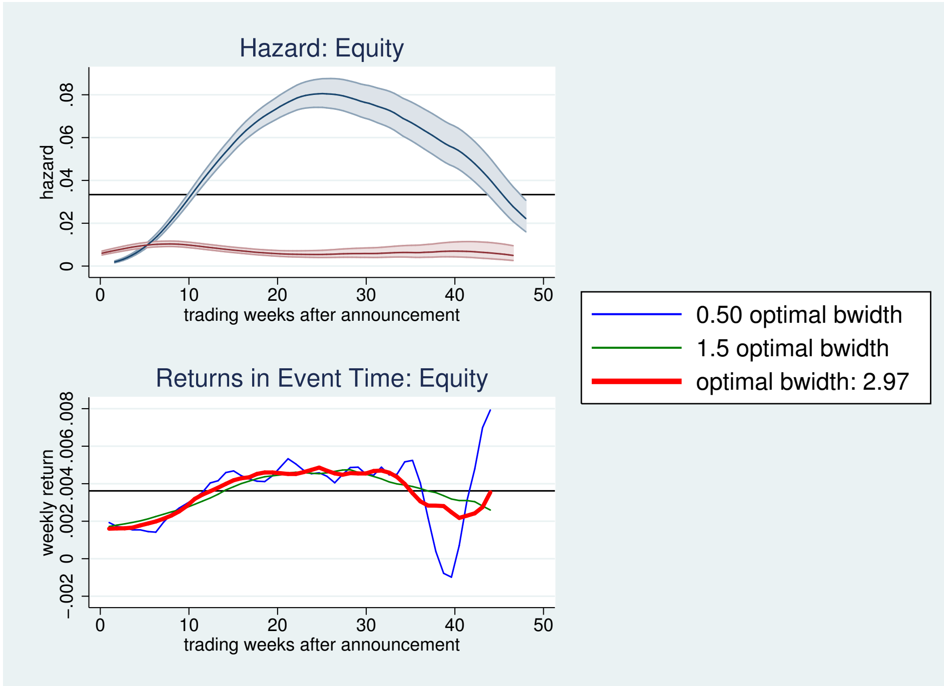

Figure 5: Hazards vs. Returns: Equity Mergers

Figures 4 and 5 plot hazard rates in the top panel and mean returns in the bottom panel. Given the amount of noise present in return data, we plot returns over event time by fitting a local polynomial to the series of returns for each deal in each event week. For robustness, we display the curve obtained using the optimal bandwidth as well as 0.5x and 1.5x the optimal bandwidth. The figures show that the hazard rate of completion and returns tend to move together in event time as predicted by the underreaction hypothesis. In the first weeks after the announcement and towards the end of the first year after announcement, completion hazards are below the average and returns are below the average as well. In the intermediate weeks, hazard rates are high and returns are high as well. Finally, returns revert to the average by the end of the last event week (week 45), consistent with the idea that investors realize after a long period of time that the hazard rate of completion has effectively become zero (but the small sample of deals that survive to the end of one year makes returns estimates one year after merger announcement particularly noisy, so it is difficult to make precise statements).

Dep Var: Weekly Returns	Full sample		Small Targets		Large Targets	
	Cash	Equity	Cash	Equity	Cash	Equity
Weekly hazard	0.0327 ***	0.0486 ***	0.058 ***	0.0673 ***	0.0103	0.0372 ***
	(0.011)	(0.011)	(0.017)	(0.018)	(0.013)	(0.014)
Calendar year x month FE	Y	Y	Y	Y	Y	Y
Obs	62685	27506	31052	14092	31633	13414
R2	0.0197	0.0171	0.0227	0.029	0.0331	0.0371

Table 2: Hazards vs. Returns

We can formally reject the hypothesis that returns are constant over event time, as predicted by a model in which the market rationally updates on no news. We estimate a regression of returns on indicators for each event week following deal announcement, with controls for calendar year-month fixed effects and with standard errors clustered by calendar year-month. We can reject that the coefficients on the event-month indicators are jointly equal to one another with p-values of 0.07 and 0.02 respectively for cash and equity deals.

Next, we test the strength of the relationship between returns and completion hazard rates. For each merger type and for each event week, we compute a time series of returns over calendar time obtained by only holding deals during that specific event week. These returns will therefore be averages across deals which are active during each event week in each calendar month.

In Table 2, we regress returns on hazard rates, controlling for calendar year-month fixed effects. The latter controls for possible time variation in unobservables that might affect returns over calendar time (for example, calendar-time variation in risk or risk premia, as discussed more in detail later). We cluster standard errors at the calendar year-month level. For both cash and equity deals, hazard rates (estimated from the aggregate sample) significantly predict returns over event time even after controlling for calendar time, as predicted by the hypothesis of underreaction to no news. This relation is significant and positive for both cash and equity deals, and holds in the full sample as well as in the early and late calendar period subsamples.

Note that the positive relation between hazards and returns is stronger in the early sample than in the late sample (with the significance disappearing for cash deals in the late sample). This is consistent with the view that, over time, sophisticated merger arbitrageurs have reduced the extent of underreaction to no news. A comparison of small and large deals suggests a similar story. We classify half of the deals as large and half as small, based upon the market equity of the target at the time of announcement relative to the mean target value in each calendar year. We estimate the relationship between hazard rates and returns separately for the small and large subsamples. We find that the relationship is more than twice as strong for the smaller half of deals than for the larger half. This is consistent with a limits to arbitrage view in which some a strict subset of investors are rational but cannot fully arbitrage away mispricing, particularly in smaller deals which tend to have higher transaction costs.

6 Risk

So far we have not explicitly considered the possibility that the positive correlation between hazard rates and returns in *event* time could be explained by event-time variation in risk or risk premia that tracks movements in hazard rates (note that we do control for *calendar* time variation in risk and risk premia in Table 2).

We tackle the issue of event-time risk in two ways. First, we compare the alphas with respect to a three-factor Fama-French (FF) model of trading strategies that only invests in deals in specific weeks. In particular, we show that a strategy that buys deals during the event window in which hazard rates are high has a significantly higher alpha than a strategy that buys deals in event weeks with low hazard rates. This shows that the relation between hazards and returns holds even after controlling for exposure to the FF factors.

Second, we try to directly rule out variation in risk over event time by looking at the variation in betas and downside betas with respect to the the three FF factors over event time.

6.1 Trading strategies and alphas

To understand how the risk exposures of deals vary over event time, we construct calendar-time returns of different portfolio strategies that are exposed only to deals active in specific event windows. We construct our strategies by modifying the traditional buy-and-hold merger arbitrage strategy described in Mitchell and Pulvino (2001).

The first step in the construction of these returns is to identify three event-time periods, based *only* on the behavior of the completion hazard rate: a first period in which the hazard rate is *below* its mean (*Low Hazard 1 period*), and second period in which the hazard rate is *above* its mean (*High Hazard period*), and a third period later in a merger's event life when the hazard is again *below* its mean *(Low Hazard 2 period).* We estimate these event windows separately for cash and equity deals. Looking at the top panel of Figure 4, it is easy to see that the cutoff for cash deals are weeks 8 and 42. For equity deals in Figure 5, the cutoffs will be 11 and 35.

Once we identify the cutoffs weeks for the three regions, we construct the monthly returns of each of the three strategies as follows. In each calendar month, we invest in all deals that are active, at the beginning of the month, in the event weeks that fall in the region associated with each of the three strategies, leaving 2 weeks around each cutoff point to distinguish more sharply between the three regions. For example, to construct the returns for the "High Hazard" strategy for cash deals, we identify all deals that at the beginning of each calendar month are active in event weeks 10 to 40. To construct the returns for the "Low hazard 1" strategy, we identify all deals that are active in event weeks 1 to 6.

For each calendar month, we construct an equal-weighted return using all selected deals. If no deals are active during the relevant event window in a given calendar month, the strategy invests in the risk-free rate. Following standard merger arbitrage strategy, we go long the target for cash deals. For equity deals, we long the target and short Δ shares of the acquirer. This ensures that the return following deal completion does not depend on the price of the acquirer at the time of completion, and makes the return series comparable to that of a cash deal. Note that while all the deals are equally weighted, we separately explore the returns of strategies that only invest in large or small deals.

Table 3 shows the alphas of the three strategies for both cash and equity deals. The top panel presents estimates for the full sample period. We find that the average returns in excess of the risk-free rate, after controlling for risk, are much higher for event weeks corresponding to high hazards than for those corresponding to low hazards: for example, for cash deals the alphas of the two "Low hazards" strategies are 1bp and -6bp per month

			Individual Strategies		Tests: P-values	
			alpha	stderr	High > Low	High > Buy and Hold > Low
Full Sample	Cash	Low hazard 1	0.0001	0.0015		
		High hazard	0.0063 ***	0.0017	0.0054	0.0067
		Low hazard 2	-0.0006	0.0037		
		Buy and hold	0.0039 ***	0.0013		
	Equity	Low hazard 1	0.0068 ***	0.0015		
		High hazard	0.0147 ***	0.0023	0.0003	0.0002
		Low hazard 2	-0.0035	0.0055		
		Buy and hold	0.0109 ***	0.0012		
		Obs	3164		Joint test	Joint test
		R2	0.082		0.0000	0.0230
Early Sample	Cash	Low hazard 1	-0.0010	0.0017		
		High hazard	0.0078 ***	0.0022	0.0023	0.0032
		Low hazard 2	-0.0031	0.0050		
		Buy and hold	0.0043 ***	0.0014		
	Equity	Low hazard 1	0.0048 ***	0.0018		
		High hazard	0.0166 ***	0.0030	0.0003	0.0004
		Low hazard 2	-0.0097	0.0086		
		Buy and hold	0.0111 ***	0.0016		
		Obs	1655		Joint test	Joint test
		R2	0.104		0.0000	0.0000
Late Sample	Cash	Low hazard 1	-0.0002	0.0022		
		High hazard	0.0045 *	0.0024	0.1530	0.1468
		Low hazard 2	0.0038	0.0065		
		Buy and hold	0.0035 *	0.0019		
	Equity	Low hazard 1	0.0088 ***	0.0022		
		High hazard	0.0153 ***	0.0031	0.0190	0.0237
		Low hazard 2	0.0036	0.0054		
		Buy and hold	0.0107 ***	0.0019		
		Obs	1507		Joint test	Joint test
		R2	0.086		0.0230	0.0239
Late Sample, Early Hazards	Cash	Low hazard 1	0.0007	0.0022		
		High hazard	0.0052 **	0.0024	0.1001	0.1114
		Low hazard 2	-0.0004	0.0059		
		Buy and hold	0.0035 *	0.0019		
	Equity	Low hazard 1	0.0082 ***	0.0024		
		High hazard	0.0139 ***	0.0029	0.0270	0.0282
		Low hazard 2	0.0036	0.0054		
		Buy and hold	0.0107 ***	0.0019		
		Obs	1476		Joint test	Joint test
		R2	0.1079		0.0177	0.0169

Table 3: No News Strategy Alphas

and statistically insignificant, while that of the "High hazards" strategies is 63bp per month (7.5% per year). Similarly, for equity deals the alpha of the "High hazards" strategy is 147bp per month (17.5% per year), higher than both "Low hazard" strategies, respectively 68bp and -35bp a year.

A central prediction of the underreaction to no news theory is that returns in the "High" periods should be on average higher than those in the "Low" period, even after controlling for risk. In the central column of Table 3 we test the hypothesis that $\alpha_{high} > \alpha_{low_1}$ and $\alpha_{high} > \alpha_{low_2}$ by computing the test for the linear combination:

$$T_{rel} = (\alpha_{high} - \alpha_{low_1}) + (\alpha_{high} - \alpha_{low_1}) \leq 0$$

versus the alternative $(\alpha_{high} - \alpha_{low_1}) + (\alpha_{high} - \alpha_{low_1}) > 0$. In other words, we reject the hypothesis of rational markets only if α_{high} is sufficiently higher than the average of two α_{low} coefficients. As shown in the table, the alpha in the "High hazards" region are significantly higher than the hazards in the "Low regions" with a p-value of less than 0.01 for both equity and cash deals.

The underreaction to no news hypothesis has predictions about the *event-time variation* of average returns, but does not have direct predictions about the *average return over the life of the merger.* Starting with Mitchell and Pulvino (2001), the risk arbitrage literature has shown that the average return of a buy-and-hold strategy (which invests in deals from announcement until completion or withdrawal) is higher than the risk-free rate even after controlling for the standard risk factors and downside risk. Within our framework, this is equivalent to saying that the *average* return around which we expect event-time variation under the underreaction hypothesis is not the risk-free rate r, but some higher value $\mu > r$. The difference between μ and r will be captured by the alpha of a buy-and-hold strategy.

In the far right column, we compare the alphas of our High and Low Hazard strategies to the alpha from a buy-and-hold strategy. In particular, our model predicts that the alpha of the High Hazard strategy should be higher than the "buy-and-hold" alpha, and in turn this one should be higher than the Low Hazard strategies. Again, we test the hypothesis by looking at the sum of the alphas, $T_b = (\alpha_{high} - \alpha_{bh}) + (\alpha_{bh} - \alpha_{low_1}) + (\alpha_{bh} - \alpha_{low_2})$. The statistic T_b will be positive if the underreaction theory is correct.

The first column of Table 3 shows that the alpha of the buy-and-hold strategy is positive and significant, 39bp per month for cash deals and 109bp per month for equity deals. In Column 3, we confirm the hypothesis of underreaction by rejecting that $T_b \leq 0$ with a (one-sided) p-value of less than 0.01 for both cash and equity deals. In other words, while the buy and hold strategy delivers a significant positive alpha, there is significant event time variation and a High Hazard (Low Hazard) strategy significantly outperforms (underperforms) the buy and hold strategy.

Similar conclusions also hold for the early and late sample periods when studied separately (second and third panels of Table 3). In all cases, the High Hazard strategy has significantly higher alphas than the Low Hazards strategy, and these are respectively higher and lower than the buy-and-hold strategy as predicted by the theory (though the test for cash deals in the late sample is not significant).

We also report report the returns of a strategy that chooses the event-time cutoffs for the High and Low Strategies based upon hazard rates estimated using the earlier 1963-1990, but which invests in deals active during the 1991-2010 sample (last panel of Table 3). This ensures that the portfolio strategy only uses existing available information on previous merger hazard rates. Given that Figure 1 showed that the shape of the hazard rate curves remained stable for the past four decades for both cash and equity deals, it is not surprising that all results hold also when performing the test using the early hazard rates.

Finally, we note that we adopted a conservative approach in constructing the return series used to compute the alphas of the various strategies presented in Table 3. Since fewer deals survive to the "Low Hazard 2" stage of the deals (since many deals have withdrawn or completed before then), it is more likely to find months with no active deals for the "Low Hazard 2" strategy than it is for the "High Hazards" strategy. Since the return of a month with no active deals is set to be equal to the risk-free rate, this may artificially bias the alpha and betas of the "low" strategy towards zero, thus hiding the true risk and return properties of deals during their last event weeks. To avoid this problem, in Table 3 we only included returns from calendar months in which active deals were available for investment.

This, however, does not represent the returns of an actual trading strategy which may need to invest in the risk free rate during calendar months in which no deals are active. For

Full Sample		Individual Strategies		Tests: P-values	
		alpha	stderr	High > Low	High > Buy and Hold > Low
Cash	Low hazard 1	0.0001	0.0015		
Cash	High hazard	0.0063 ***	0.0017	0.0014	0.0011
Cash	Low hazard 2	-0.0006	0.0027		
	Buy and hold	0.0039 ***	0.0013		
Equity	Low hazard 1	0.0067 ***	0.0014		
Equity	High hazard	0.0131 ***	0.0020	0.0000	0.0000
Equity	Low hazard 2	-0.0030	0.0008		
	Buy and hold	0.0109 ***	0.0012		
	Obs	3748		Joint test	Joint test
	R2	0.0832		0.0000	0.0000

Table 4: No News Strategy Alphas - Tradable

completeness, in Table 4 we repeat the exercise including *all months* for all strategies, thus forming a tradable portfolio strategy. All the previous results hold.

6.2 Variation in betas over event time

We also explore time variation in *risk* over event time by looking directly at the betas of the various strategies. Table 5 reports the strategy betas with respect to the three Fama-French factors. The top panel shows that the betas are all generally quite small, between -0.1 and 0.3.

The middle panel of Table 5 directly asks the question: could the higher returns of the "high" strategy relative to those of the "low" strategy be due to higher risk in the former relative to the latter? We test this hypothesis by testing the difference in the betas among regions. We cannot reject the hypothesis that betas of the low regions are at least as high as the betas of the high region. In fact, not only is the difference statistically insignificant: the magnitude of this difference is also extremely small in economic terms, always less than 0.15.

The bottom panel of Table 5 examines whether the relationship between hazard rates and returns can be explained by event-time variation in down-side risk. As shown in Mitchell and Pulvino (2001), returns from a standard merger arbitrage strategy (enter at deal announcement and hold until either deal completion or withdrawal) partly reflect compensation for downside risk. In essence, returns from such a strategy covary relatively more with the

Panel A: Betas		Rm-Rf beta	SMB beta	HML beta	Obs	R2
Cash	Low 1	0.2209 ***	0.1594 ***	0.0862		
		(0.046)	(0.039)	(0.073)		
	High	0.2935 ***	0.2096 ***	0.1565 *		
		(0.066)	(0.059)	(0.086)		
	Low 2	0.1516	0.1472	0.0607		
		(0.115)	(0.123)	(0.152)		
Equity	Low 1	-0.1046 ***	0.0954 **	0.0146	3164	0.082
		(0.034)	(0.043)	(0.051)		
	High	-0.1179 *	0.0805	-0.0224		
		(0.059)	(0.061)	(0.080)		
	Low 2	-0.0123	0.0236	0.0720		
		(0.013)	(0.017)	(0.159)		

Panel B: Tests on Betas		Rm-Rf beta	SMB beta	HML beta
Cash	High > Low 1	0.1639	0.2000	0.2245
	High > Low 2	0.1468	0.3016	0.2926
Equity	High > Low 1	0.9229	0.9170	0.8429
	High > Low 2	0.9847	0.1963	0.7990

Panel C: Extreme Markets		Avg. return	Alpha	Rm-Rf beta	SMB beta	HML beta	Obs	R2
Rm-Rf < -3%								
Cash	Low 1	-0.0141	0.0148 *	0.3835 ***	0.2356 **	-0.0782		
		(0.004)	(0.008)	(0.095)	(0.101)	(0.176)		
	High	-0.0108	0.0188 ***	0.4281 ***	0.2493 **	0.034		
		(0.004)	(0.007)	(0.119)	(0.110)	(0.167)		
	Low 2	-0.0109	0.0209	0.4345	-0.1421	-0.2636		
		(0.011)	(0.024)	(0.357)	(0.336)	(0.275)		
Equity	Low 1	0.0149	0.0122 *	-0.0491	0.3149 ***	0.2067 **	405	0.209
		(0.003)	(0.006)	(0.107)	(0.095)	(0.095)		
	High	0.0226	0.0204 **	-0.0906	0.1904	-0.0546		
		(0.005)	(0.008)	(0.149)	(0.148)	(0.156)		
	Low 2	-0.0122	-0.0855	-1.2620 *	0.1672	-0.0236		
		(0.015)	(0.057)	(0.755)	(0.308)	(0.345)		

Table 5: No News Strategy Betas

market during strong market downturns. For downside risk to explain the positive relationship between hazard rates and returns, it must be the case that downside risk covaries with hazard rates over the event life of the merger. Empirically, we do not find this to be the case. The average return of all strategies are only mildly negative (around -1% or positive) during times when the market has a monthly return of -3%. When betas are computed during those times, they rise slightly but not by enough to justify the alphas of these strategies as compensation for "downside risk". In addition, it is again clear that the average returns during down markets are *not* lower for the "High hazards" strategy than for the "Low hazards" strategies. This suggests that, while some of the excess returns to merger arbitrage may in part be due to compensation for down-side risk, this downside risk does not vary over event time and cannot explain the correlation between hazard rates and returns.

Overall, the results in Table 5 indicate that the difference in average returns and alphas of the "High" vs. the "Low" regions do not correspond to different exposure to the three Fama-French factors, nor to a different exposure to particularly low markets returns.

To exclude changes in risk over event time, we can also look directly at the event-time variation in the betas. To do so, for each of the 45 possible event weeks in a deal's event life, we construct a calendar-time series of returns of a portfolio that buys deals that are active in that precise event week only (separately for cash and equity deals). We then construct a panel of calendar time returns for each of the 45 event-week portfolios. We compute the calendar time betas of all of these portfolios with respect to the market return, SMB and HML, and plot the betas in Figure 6, with cash mergers in the top panel and equity mergers in the bottom panel.

The Figure points to two important features of these portfolio returns. First, the betas with respect to *all* the Fama-French factors are again generally very small (the market beta is usually less than 0.2). The magnitude of the betas cannot account for the difference in the alphas we observe in our High Hazard period (between the green bars) and the Low Hazards periods (the far left and right regions). Second, there does not seem to be significant time variation in any of the betas over event time.

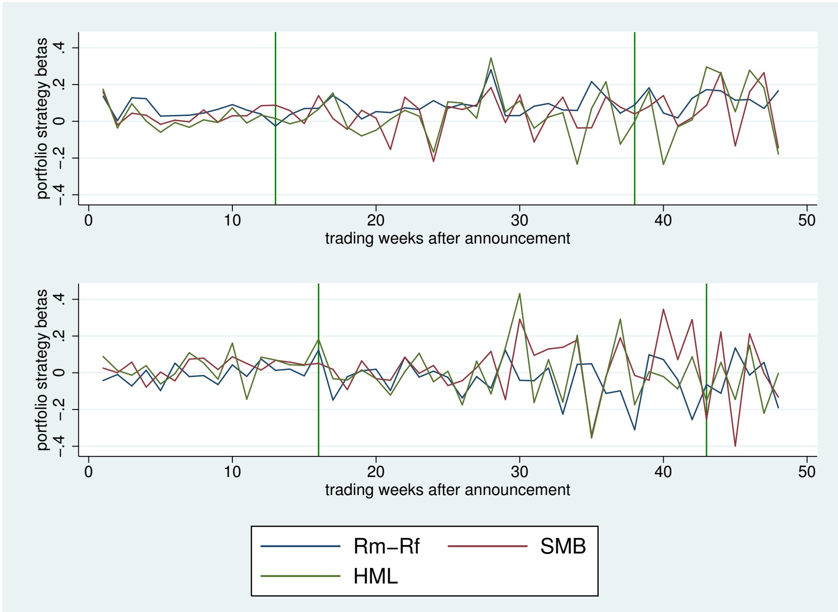

Figure 6: Event-time variation in risk

Dep Var: Betas	Rm - Rf	SMB	HML
Weekly hazard x Cash	-0.454	-0.488	-0.676
	(0.687)	(1.056)	(1.139)
Weekly hazard x Equity	-0.039	0.425	-0.128
	(0.460)	(0.062)	(0.066)
Merger type dummies	Y	Y	Y
Obs	96	96	96
R2	0.35	0.01	0.02

Table 6: Time-varying betas

In Table 3 we test whether betas vary in a systematic way with hazard rates over event time. We find that the relationship between betas and hazard rates is a well-estimated zero. The point estimates of the relationship are negative. The economic magnitude of the estimated relation is also extremely small: one standard deviation increase in the hazard rate corresponds to a reduction in each of the betas of around of 0.01.

7 Robustness

The regression results in Table 3 derive from trading strategies that uses precise cutoffs using the estimated hazard rates presented in Figures 1 and 2. In this section we show that these results are extremely robust to variation in the exact cutoff levels.

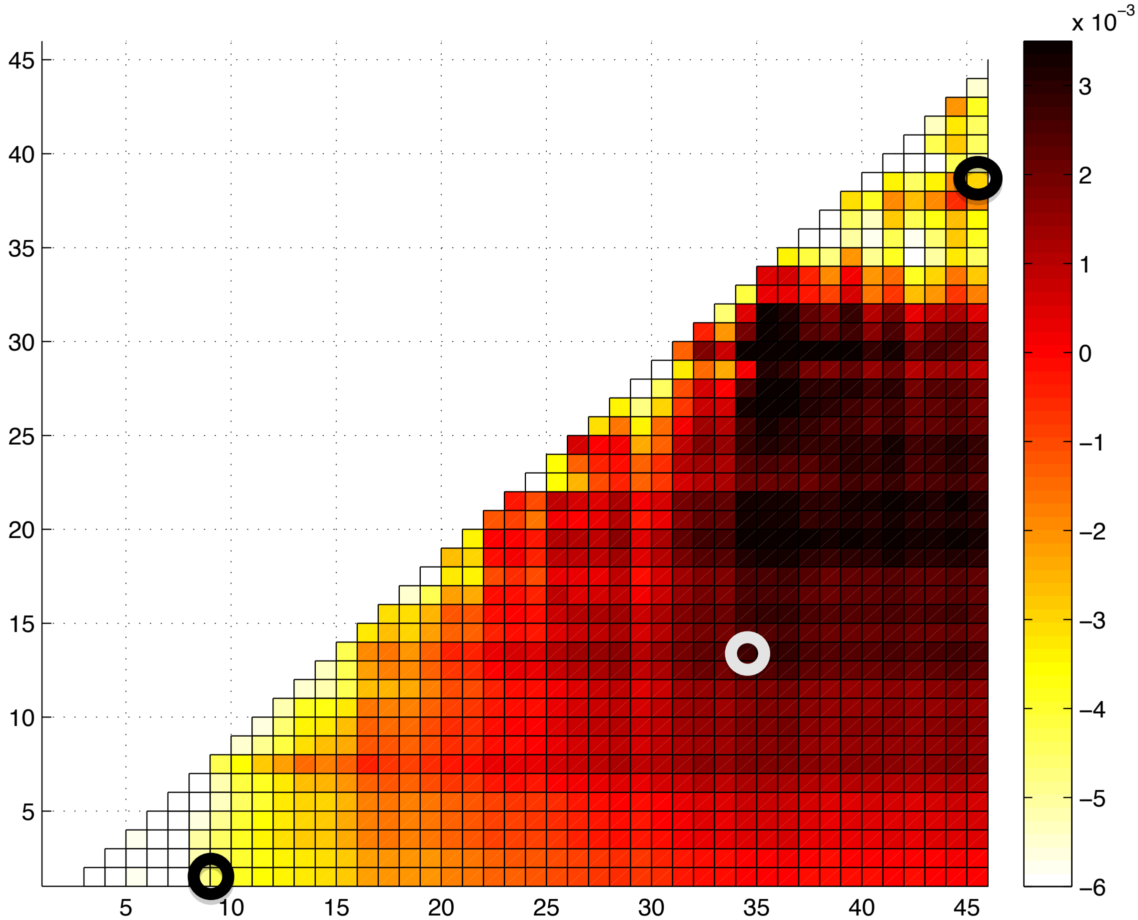

Figure 7: Hazards vs. returns, cash

Figures 7 and 8 report the *difference* between the alpha of a strategy that buy deals in weeks t_1 to t_2, and the alpha of the buy-and-hold strategy (that buys deals active in event weeks 1 to 45, i.e., all deals). t_1 can be read on the vertical axis, and t_2 on the horizontal axis.

To illustrate the figure with an example, consider cash deals in Figure 7. The "Low hazards 1" strategy buys at week 1 and sells at week 9, so its alpha can be read as (t_1 =

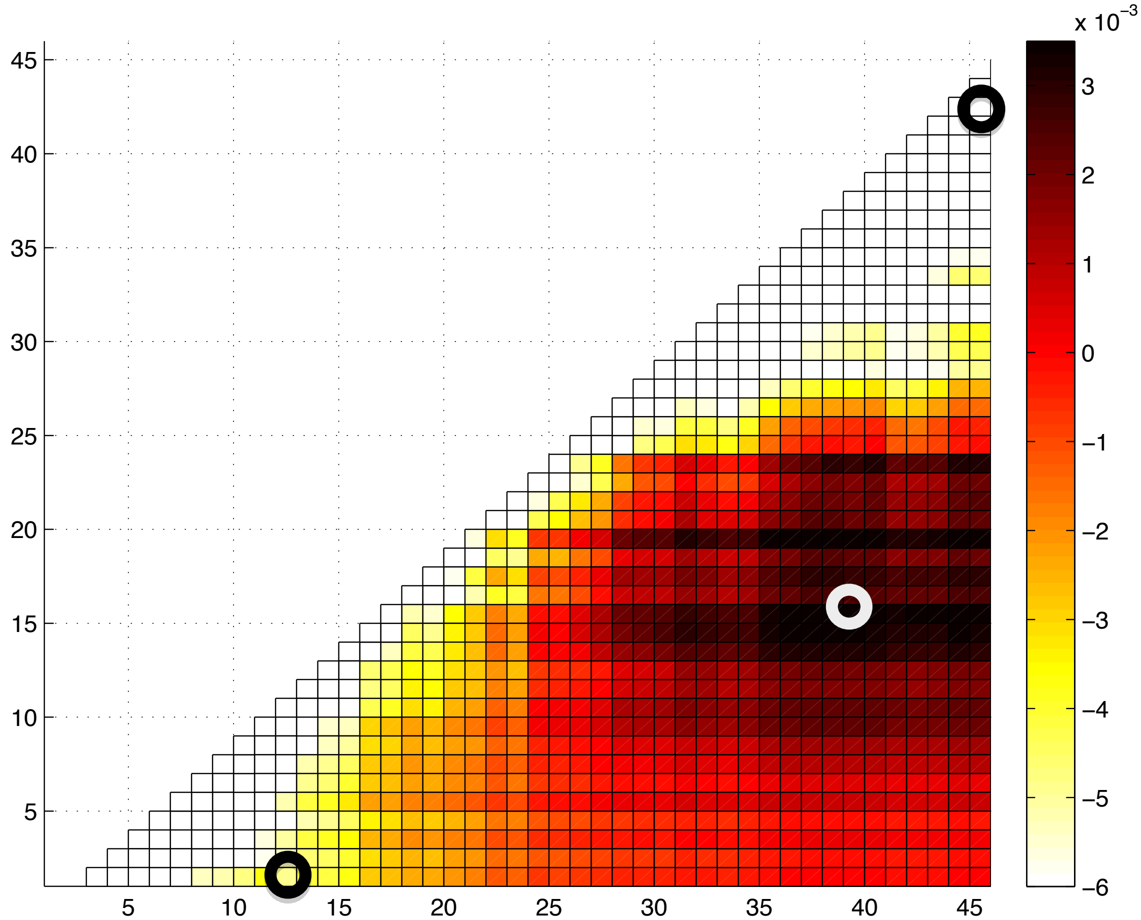

Figure 8: Hazards vs. returns, cash

$1, t_2 = 9$): the circle at the bottom left. The circle in the middle corresponds to the "High hazards" strategy and the circle on the top right corresponds to the "Low hazards 2" trading strategy. The bottom-right corner ($t_1 = 1, t_2 = 45$) corresponds to the buy-and-hold strategy. Since the graph reports alphas of the strategies relative to the buy-and-hold strategy, it is not surprising to find exactly 0 at (1,45), negative numbers for the "Low hazards" strategies, and a positive number for the "High-hazard" strategy.

Starting from the circles representing the three trading strategies, it is easy to see robustness in the variation of cutoff points in all directions. The "Low-hazard" strategies lie in an area with negative alphas (relative to the buy and hold). Meanwhile, the "high-hazard" strategy lies in an area with all positive alphas (relative to the buy and hold). This shows that the results on the alphas do not strictly depend on the cutoff points, but more generally align quite well with the high- and low- return areas predicted by the underreaction to no news hypothesis. This holds for both cash and equity deals.

8 Conclusion

The absence of news and the pure passage of time often contain important information. Rational updating on the pure passage of time offers one explanation of why prices can drift even in the absence of news. However, no news, by definition tends to be less salient and vivid than traditional news stories. Limited attention and the base rate fallacy may lead boundedly rational investors to underreact to the passage of time.

In this paper, we test how markets react to "no news" using the empirical context of mergers. Following the initial merger announcement, uncertainty relating to merger completion can take several months to a year to be resolved. We find that hazard rates of merger completion vary strongly over time after the merger announcement, implying that the pure passage of time (i.e., no news) can predict merger completion. If markets are rational, prices should correctly incorporate this information. When we examine target return patterns, we find that the aggregate merger completion hazard rates are positively correlated with target returns. This is consistent with a limited attention model in which the agents underreact to the passage of time, but not with a model in which agents rationally update beliefs on days without news.

While the positive relationship between returns and hazard rates is consistent with underreaction to no news, it could also be explained by changes in risk over the event life of the merger. We show that not only average returns, but also alphas from a Fama-French 3 factor model are higher for a strategy that buys deals during high-hazard event weeks than for a strategy that buys deals during low-hazard event weeks. In addition, using a multiple portfolios strategy that invest only in deals active in each event week, we estimate the risk associated with each week in a merger's event life. We find that merger returns have low betas in general and risk, including down-side risk, does not vary with hazard rates over the event life of the merger. We conclude that aggregate hazard rates of merger completion predict merger returns because markets underreact to the passage of time.

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