Do mergers and acquisitions affect information asymmetry in the banking sector?

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Abstract

Purpose – This paper aims to investigate the consequences of mergers and acquisitions (M&As) on information asymmetry in the banking sector. Specifically, the authors look at whether specific firm or deal characteristic influence information asymmetry levels between insiders and investors, as well as the impact of recent regulation such as the Dodd–Frank Act.

Design/methodology/approach – The authors decompose the M&A process into three periods (pre-announcement, negotiation and post-completion period) and document changes in the information asymmetry levels between insiders and investors through the M&A process. The authors capture changes in information asymmetry using six different spread-based information asymmetry measures.

Findings – The authors find evidence that information asymmetry increases following M&A announcement and decreases following deal completion. These findings are more pronounced for acquisitions involving a private target, all-cash deals and for mergers, as opposed to acquisition of assets. We find that overall, successful mergers improve the quality of the information environment, while failed deals degrade it. Additionally, the enactment of Dodd–Frank reduced the magnitude of the changes in information asymmetry during the M&A process. The results are important to regulators, policy makers and investors.

Originality/value – To authors' knowledge, this is the first study that looks at the effect of bank M&As on information asymmetry as well as the effect of regulations on information asymmetry.

Keywords Transparency, Banking, Dodd–Frank, Information asymmetry

Paper type Research paper

Information asymmetry and bank mergers

Regulators, in particular banking and financial regulators, are needed to combat information asymmetry. The financial and banking crisis of 2008 showed the extent of this asymmetry and, in fact, the inability of regulators to remedy it. In general, the global financial crisis was often later characterized as a crisis of regulators and regulation [1].

1. Introduction

In recent years, mergers between and acquisitions of banks have materially altered the market structure of commercial banking in the USA and pose a challenge to regulators who must evaluate the micro- and macroprudential implications of the transactions [2]. Given the importance of financial markets and institutions to economic growth (e.g. Levine and Zervos, 1998) as well as banks' involvement in the 2007–2009 financial crisis, the efficacy of banking regulation has wide-ranging implications.

A challenge facing bank regulators is information asymmetry (IA); the inability to know all that the bank's managers know about the financial health of the firm. Reliable information is especially important for regulators as they assess the desirability of a merger or acquisition

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[3]. For example, are there economies of scale or other types of efficiencies? What will be the impact of the transaction on systemic risk? Is there a sufficient resource commitment to integrate the two banks? Are the risk cultures of the two banks compatible? Answers to these questions can also inform the decisions made by policy makers about changes in the policies and procedures that guide regulators.

We use equity market-based measures of IA to proxy for the knowledge that transaction insiders have that outside investors do not. The asymmetry is important for equity investors because it reflects the possibility of surprises (both positive and negative) about the proposed transaction. Investors form expectations about the expected terms of the deal as well as its probability of occurring. Deviations from these expectations are a source of additional idiosyncratic risk, above that associated with the day-to-day operations of the bank. For investors with less than full diversified portfolios, the increase in risk can be significant and is not compensated with a higher expected return.

In this paper, we examine the evolution of IA during bank mergers and acquisitions (M&As). We study banks because of their centrality in the financial system. Banks are critical to the payments system and the creation of credit. The high degree of systemic risk in the banking industry makes it distinct from other industries. Banks are also highly regulated, and their systemic risk poses challenges for policy makers, regulators and investors. For these reasons, banks are worthy of independent investigation.

We find that IA increases following initial M&A announcements and decreases following deal completions. The findings are stronger for acquisitions involving private targets, mergers (as opposed to acquisitions) and all-cash deals. Relative to the pre-announcement period, mergers reduce IA after completion and failed deals increase it. We also find that the enactment of the Dodd–Frank Act reduced the magnitude of the changes in IA during the M&A process.

The implications of our findings are as follows. First, the period between the announcement of a deal and its completion (the "negotiation" period [4]) is a time during which regulators might invest more in monitoring the banks involved, especially for private targets, mergers and cash deals. Second, in spite of the criticism of the Dodd–Frank Act (e.g. "The right way to redo Dodd-Frank," *The Economist*, February 11, 2017), our evidence suggests that it resulted a reduction in the variability of IA, thus mitigating the IA challenge faced by regulators, thus potentially creating greater stability of the financial system. Third, given the higher level of IA during the negotiation period, there is greater opportunity for both informed and (corporate) insider trading. Consequently, uninformed investors are at a greater-than-normal disadvantage during this period.

Our study contributes to the existing literature in at least four ways. First, we decompose the M&A process into three periods and document changes in IA levels between insiders and investors through the M&A process. Second, we show that deal characteristics directly influence the information environment. The period between the announcement of the merger and its completion is particularly opaque for all-cash deals, as well as acquisitions of private targets, and that a reversal occurs (i.e. a decrease in opacity) following deal completion. Third, we contribute to the IA literature by adding to the understanding of the impact of a major corporate event on the information environment. Finally, our findings suggest that the Dodd–Frank Act reduced the level of IA as well as the magnitude of changes in IA around the announcement and the completion of mergers in the banking sector.

2. Information asymmetry

IA has been shown to affect prices (Easley *et al.*, 2002), cost of capital (Botosan, 1997) and trading volume (Atiase and Bamber, 1994; Krinsky and Lee, 1996). The accounting literature has extensively documented the effects of disclosure on IA between managers and investors

(Spiegel and Subrahmanyam, 2000; Core, 2001) and most especially investigated the release of bad news (Skinner, 1994; Healy and Palepu, 2001).

A stream of the literature investigates the impact of IA in the banking sector. Morgan (2002) argues that bond raters are significantly more likely to disagree over bank and insurance companies' issuances, consistent with a greater opacity surrounding financial firms. Haggard and Howe (2007) reach a similar conclusion, showing that banks' equity returns are not as rich in firm-specific content as that of industrial firms. Flannery *et al.* (2004) find evidence that although financial institutions are not unusually opaque, smaller banks are less transparent than their non-financial counterparts, trading much less frequently and exhibiting lower volatility.

Several factors drive IA for financial firms. Jiang *et al.* (2016) and Jungherr (2018) argue that increased competition decreases bank opacity. Jones *et al.* (2013) quantify the impact of opacity on profitability and valuation. They find that IA attributable to investments in opaque assets lead higher discount rates and consequently higher valuations. Consistent with that finding, Fosu *et al.* (2017) argue that opaque banks are at higher risk of insolvency.

Another stream of the literature shows that firm characteristics and events influence IA. Aboody and Lev (2000) show that research and development (R&D) increases IA. Chae (2005) investigates the relationship between trading volume and IA. Looking at scheduled and unscheduled corporate events, she finds that IA changes around these events and a negative relation between trading volume and IA before scheduled announcements but positive after announcements. More recently, Kalay (2014) shows that the information environment influences dividend payouts, and Haggard *et al.* (2015) show that accounting baths decrease IA.

We argue that M&As are economically significant events that act as a catalyst for changes in IA (Jones *et al.*, 2012). The cost and consequences associated with IA further motivate the study of the impact of M&As on the information environment. Specific regulations and scrutiny over financial institutions make the banking industry particularly interesting to study as extra governmental regulations are likely to create additional IA between investors and insiders (Flannery *et al.*, 2004). In the remainder of the section, we describe a framework for thinking about the evolution of IA over the course of a merger or acquisition. The narrative motivates our use of spread-based measures of IA.

2.1 The pre-announcement period

Before the public announcement of a potential deal, there is a level of IA related to the day-to-day operations of the (acquiring) bank. This level of IA is the baseline for our empirical analysis and depends on a variety of factors. For example, deregulation of the banking industry has led to greater competition and an accompanying reduction in bank opacity (Jiang *et al.*, 2016). Other factors include the intensity of monitoring by regulators and the types of loans and other assets held by the bank. The economic actors in this period are the acquiring firm's managers and their financial advisors, market makers and uninformed investors [5].

2.2 The negotiation period

The initial announcement of a potential deal marks the beginning of a period during which the acquiring and target firm negotiate the terms of the deal. During this period, the initial bid might change, and other bidders could arrive. Because the negotiations occur behind closed doors, there is likely to be an increase in IA during this period (we formally describe our hypotheses in the next section). The economic actors in this period are the acquirer's managers and their investment advisors, the target's managers and their investment advisors, market makers and risk arbitrageurs – arguably informed investors who are a risk to market makers.

2.3 The completion period

The completion period begins when the merger is effective. Starting at this time, there is no longer uncertainty about whether the deal will go through or the terms of the deal. We hypothesize that IA will decline following deal completion relative to the negotiation period. The information released over the course of the M&A timeline might even lead to lower levels of IA in the completion period relative to the pre-announcement period.

2.4 Spread-based measures of information asymmetry

The literature contains a wide variety of proxies for IA. Morgan (2002) investigates bond-market-based IA measures (IAMs) by looking at bond ratings dispersion to evaluate opacity. Jones *et al.* (2012, 2013) look at balance-sheet-based IAMs to investigate the impact of opaque assets such as commercial and residential real estate loans and mortgage-backed securities on price synchronicities. Fosu *et al.* (2017) use analyst forecasts-based IAMs to evaluate banking system opacity and its impact on risk-taking. Recently, Haggard *et al.* (2015) use 11 IAMs, including equity market-, volatility- and analyst-based measures. However, there is ambiguity about what some of the measures are capturing. In particular, Chae (2005) argues that return-based measures can move in the opposite direction of changes in IA. Given the wide acceptance of the role that IA plays in determining bid and ask prices, we use spread-based measures. Spread-based measures are subject to estimation error, so we use six measures to assess the robustness of our results.

The bid–ask spread consists of at least two components, one due to IA and the other consisting of inventory costs, specialist monopoly power and clearing costs (Glosten and Harris, 1988). Glosten and Harris conclude that a "significant amount" of spreads are due to IA. There is some debate about the relative size of the spread components, especially for small trades (George *et al.*, 1991). Nonetheless, changes in the IA component, regardless of their relative size, are indicative of changes in environmental IA.

There is an important distinction between uncertainty and IA. At the beginning of the negotiation period, there is a substantial amount of uncertainty, although the range of possible outcomes is nonetheless limited (e.g. the acquiring firm is not going to offer a 400% premium to market price). But, as the negotiations continue, the range of possibilities becomes smaller, and this knowledge is known only by the acquirer's managers and their investment advisors, the target's managers and their investment advisors, possibly market makers and risk arbitrageurs. The new information is not known to outside investors until the completion of the deal is finalized and announced. Thus, the convergence to deal terms creates IA during the negotiation period.

3. Hypothesis development

We divide the M&A process into the three periods. First, the pre-announcement period (period 1) consists of the 42 trading days before the announcement of a merger. Second, the negotiation period (period 2) refers to the number of trading days between the announcement of a merger and its completion (the median is 167 days). Third, the post-completion period (period 3) consists of the 42 trading days that follow the completion of a merger [6]. We hypothesize that both the initial announcement and the completion of a deal influence the level of IA.

Specifically, we posit that IA increases following deal announcements. M&As are significant investments that require complex and often lengthy negotiation processes during which the two partners negotiate the terms of the deal. Because negotiations occur behind closed doors, there is a greater information gap between insiders and outsiders about the terms of a deal and its likelihood of success. Consequently, we predict that IA will be higher in the negotiation period 2 than in the pre-announcement period 1.

Because there is no uncertainty regarding the terms of a deal or the likelihood of its success following its completion, we predict that IA will decline following the completion of a deal, i.e. IA will decline in period 3 compared to period 2. We further conjecture that IA levels will revert to *ex ante* levels following completion and could conceivably decrease even lower if relevant information about the banks' operations has been released during the negotiation period, i.e. IA levels will be similar or lower in period 3 compared to period 1.

H1. IA increases following the announcement of a deal, then decreases following the completion of the deal.

Next, we argue that the changes observed in the level of IA are affected by target and deal characteristics. For example, the type of target acquired likely impacts the magnitude of changes in IA. Because it is costlier to acquire information about private firms, there is less information about the target company for acquisitions involving private targets compared to public targets for which information is more readily accessible. We, thus, expect that the magnitude of changes in IA during each stage of the M&A process will be greater when the target is private.

Deal type also likely influences the magnitude of the changes in IA around our cutoff points of interest. In a merger, the target is outright absorbed by the acquirer and ceases to exist as a separate entity, while the bidding firm acquires all of the target's assets and liabilities (Ross *et al.*, 2016). Acquisitions of assets are typically less complex and involve fewer intermediate steps (Reed *et al.*, 2007), suggesting that the magnitude of changes in IA should be stronger (weaker) for mergers (acquisitions).

The method of payment might impact changes in IA. Because all-stock deal returns tend to be less volatile than that of all-cash deals (Betton *et al.*, 2008a), we posit that all-cash deals are likely generate greater changes in IA. Additionally, Officer *et al.* (2008) assert that stock offers are a way for the bidder to share overvaluation risk with the target. As such, stock offers are less risky for the acquirer, especially when the target is hard to evaluate. On the other hand, all-cash deals are riskier as they expose the bidder to potential target overvaluation.

H2. Deal characteristics influence the magnitude of IA changes. Changes in IA during the three periods of interest are likely to be more pronounced for private targets, for mergers as opposed to acquisitions and for all-cash deals [7].

We next investigate the long-term impact of M&As on IA. Haggard *et al.* (2015) find that accounting baths increase IA in the short term, but that this effect reverses itself over time, and that IA actually decreases over the long term. To explain this pattern, the authors argue that baths are viewed as negative events (Elliott and Shaw, 1988), and that negative information takes time to process (Francis *et al.*, 2007). M&As do not suffer from this negative perception, and as such, we expect the market reaction to be persistent over the long term.

H3. The long-term impact of M&A on bank IA is permanent.

The net effect of M&As on bank IA also depends how targets are impacted. Information flow is arguably less complex for targets because they typically receive significant premiums. Consequently, we posit that target IA will decrease significantly following the announcement of a deal.

H4. Target IA decreases following deal announcement.

Our remaining hypothesis pertains to the impact of the Dodd–Frank Act, enacted July 21, 2010. The Act was intended to make the banking system safer. Its goals included reducing IA between insiders and shareholders through a reduction in the ability of commercial banks to take risks and an increase and regulation of public disclosures "in order to support market

evaluation of the risk profile, capital adequacy, and risk management capabilities" [8]. We investigate whether the Dodd–Frank Act influenced the information environment. If it did, the magnitude of the changes in IA around the two stages of the M&A process will be reduced after passage of the Act. If it did not, the magnitude of the changes in IA should be similar before and after the passage of the Act.

H5. The magnitude of the changes in IA following the announcement or the completion of a deal are reduced after passage of the Dodd–Frank Act.

4. Data selection and empirical design

4.1 Data selection

From SDC, we identify all the completed domestic M&As in the banking sector from 1980–2016. Following Moller *et al.* (2005), we apply the following filters:

(1) The acquirer and the target are domestic banks (Compustat primary SIC code between 6020 and 6030).

(2) The acquirer is a public firm.

(3) The deal is worth at least US$1m in value.

(4) The acquirer owns less than 50% of the target's shares before the merger.

(5) The acquirer owns 100% of the target's shares after the merger.

We merge the dataset with Compustat to obtain information on banks' fundamentals. Following Haggard *et al.* (2015), we control for size (total assets), book-to-market ratio, debt-to-equity ratio and income scaled by lagged assets. We retain deals for which we are able to obtain daily stock price data from the Center for Research in Security Prices (CRSP). This approach yields 3,146 deals. Figure 1 displays the distribution of the mergers over time. There

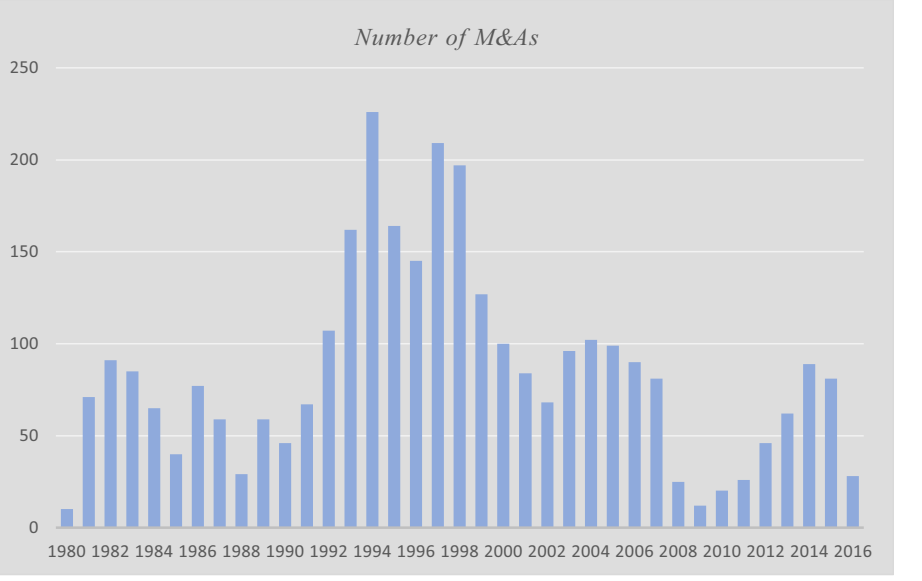

Figure 1.
Distribution of M&As over time

are periods of heightened consolidation of the banking sector, especially during the 1990s. In the robustness section, we show that our results are not sensitive to merger waves.

4.2 Information asymmetry measures (IAMs)

Following Haggard *et al.* (2015), we use equity market-based measures to investigate the effect of M&As on the information environment by looking at six different IAMs [9] We use a window of 42 trading days before the announcement date to 42 trading days after the completion date; the results are not sensitive to the length of the pre- and post-periods.

We use six different spread-based variables. We calculate *Daily spread* as the daily difference between the daily high and low trading prices divided by the closing price. *HL spread* is the daily estimated effective spread calculated as in Corwin and Shultz (2012). *Roll* is the daily covariance in prices (Roll, 1984). *PQ spread* is the difference between the closing bid and ask prices divided by the closing bid–ask midpoint. *Effective spread* is twice the absolute value of the price minus the bid–ask midpoint. *PE spread* is twice the absolute value of the price minus the bid–ask midpoint scaled by price. We follow Chordia *et al.* (2000) in calculating *PQ spread, Effective spread* and *PE spread*.

4.3 Empirical design

We use December year-end information in year t – 1 to calculate firms' fundamentals for the subsequent year. We divide the process into three periods as displayed in Figure 2. We define the pre-announcement period as period 1, the negotiation period as period 2 and the post-completion period as period 3. Consistent with the work of Schwert (1996) and Betton *et al.* (2008) on the M&A run-up period, we define the pre-announcement period 1 as the 42 trading days prior to the announcement date of the deal. The negotiation period 2 is the transition period that separates the date the merger is announced from the date the merger is completed. When the announcement date or the completion date occurs on a non-trading day, the next trading day is the cutoff for the relevant period. The post-completion period 3 consists of the 42 trading days after the date the merger is completed. We create indicator variables to capture the variation in IA over the three periods of interest.

We run pairwise tests by looking at changes to the information environment between two specific periods of interest. This approach allows for an easy interpretation of the coefficient of interest as the change from one period of interest to another. Consequently, for each hypothesis, we run three pairwise tests, i.e. we run three tests comparing each period directly to another, while excluding the third.

(1) When testing changes in the information environment immediately following the announcement of a deal, we compare the pre-announcement period to the negotiation period (1 vs 2) by excluding all observations from period 3. We run the ordinary least squares (OLS) model shown in equation (1), which estimates the change in IA as measured by each of our IAMs:

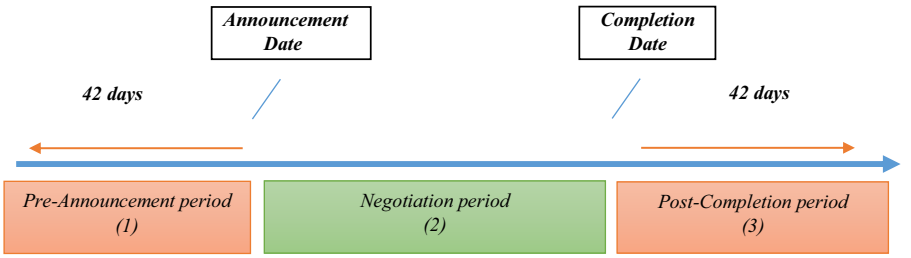

Figure 2.
The M&A process

$$\mathrm{IAM}_{i,t} = \beta 0 + \beta 1\ \mathrm{Negotiation}_{i,t} + \gamma 1\ \mathrm{Deal-level\ controls}_{i,j} + \gamma 2\ \mathrm{Firm\ Controls}_{i,y-1} \quad (1)$$

The coefficient of the *Negotiation* variable indicates the change in IA in the negotiation period compared to the pre-announcement period.

(2) When testing changes in the information environment immediately following the completion of a deal, we compare the negotiation period to the post-completion period (2 vs 3) by excluding all observations from period 1. We run the OLS model shown in equation (2), which estimates the change in IA as measured by each of our IAMs:

$$\mathrm{IAM}_{i,t} = \beta 0 + \beta 1\ \mathrm{Postcompletion}_{i,t} + \gamma 1\ \mathrm{Deal-level\ controls}_{i,j} + \gamma 2\ \mathrm{Firm\ Controls}_{i,y-1} \quad (2)$$

The coefficient of the *Post-Completion* variable indicates the change in IA in the post-completion period compared to the negotiation period.

(3) Finally, when testing whether the quality of the information environment reverts to its *ex ante* level, we compare the pre-announcement period to the post-completion period (1 vs 3) by excluding all observations from period 2. We run the OLS model shown in equation (3), which estimates the change in IA as measured by each of our IAMs:

$$\mathrm{IAM}_{i,t} = \beta 0 + \beta 1\ \mathrm{Post\ completion}_{i,t} + \gamma 1\ \mathrm{Deal-level\ controls}_{i,j} + \gamma 2\ \mathrm{Firm\ Controls}_{i,y-1} \quad (3)$$

The coefficient of the *Post-Completion* variable indicates the change in IA in the post-completion period compared to the pre-announcement period.

In each model, $\gamma 1$ is a vector of deal-level variables that influence the information environment, such as the value of the transaction, the method of payment, the type of deal, the attitude of the buyer and a tender offer indicator. $\gamma 2$ is a vector of firm-level controls, including book-to-market, debt-to-equity, total assets and income scaled by lagged total assets. We cluster standard errors by firm and year-month. In our tests of the impact of the Dodd–Frank Act on changes in IA, we use the specification in equation (4) as follows:

$$\mathrm{IAM}_{i,t} = \beta 0 + \beta 1\ \mathrm{Dodd-Frank}_{i,t} + \beta 2\ \mathrm{Dodd-Frank}_{i,t}{*}\mathrm{Period\ of\ interest}_{i,t} + \beta 3\ \mathrm{Period\ of\ interest}_{i,t} + \gamma 1\ \mathrm{Deal-level\ controls}_{i,j} + \gamma 2\ \mathrm{Firm\ Controls}_{i,y-1} \quad (4)$$

where *Dodd-Frank* is an indicator variable equal to 1 if the observation occurs after the passage of the Dodd–Frank Act, 0 otherwise, and *Period of interest* Dodd – Frank* is the interaction between *Dodd-Frank* and the appropriate *Period of interest*.

4.4 Summary statistics

Table 1 provides details on the sample as well as summary statistics for the IAMs and control variables. To mitigate the impact of outliers, we winsorize IAMs and control variables at the 1% level, in conformity with past literature. *Panel A* breaks down the composition of our sample. Our sample comprises 3,146 deals representing 651,123 individual firm-day

Panel A: Full sample	
Firm-day observations	651,523
Pre-announcement period	130,251
Negotiation period	388,743
Post-completion period	132,529
Number of individual mergers	3,146
Number of individual acquirers	582

Panel B: Deal characteristics Target studies	*N*	%
Mutual	9	0.29
Private	1,440	45.77
Public	1,424	45.26
Subsidiary	273	8.68
Deal type		
Acquisition of assets	438	13.92
Merger	2,708	86.08
Deal nature		
Friendly	3,113	98.95
Neutral/hostile	33	1.05
Method of payment		
All-cash	467	14.84
All-stock	1,470	46.73
Mixed	1,209	38.43

Panel C: Summary statistics – full sample IAMs	*N*	Mean	Median	SD
Daily spread	535,471	0.281	0.250	0.372
PQ spread	535,471	0.015	0.009	0.019
Effective spread	535,471	0.242	0.125	0.370
PE spread	535,471	0.009	0.004	0.014
HL spread	612,588	0.009	0.005	0.013
Roll	535,471	0.391	0.250	0.497
Controls				
Total assets$_{t-1}$	3,146	24,560	4,641	113,244
Book to market$_{t-1}$	3,146	0.675	0.631	0.302
Debt to equity$_{t-1}$	3,146	1.718	1.407	1.299
Income scaled$_{t-1}$	3,146	0.012	0.012	0.005

Panel D: IAM summary statistics per period of interest	Pre-announcement (1)		Negotiation (2)		Post-completion (3)	
IAMs	*N*	Mean	*N*	Mean	*N*	Mean
Daily spread	108,357	0.285	313,614	0.284	113,500	0.262
PQ spread	108,357	0.015	313,614	0.015	113,500	0.014
Effective spread	108,357	0.246	313,614	0.245	113,500	0.227
PE spread	108,357	0.009	313,614	0.010	113,500	0.009
HL spread	121,616	0.009	364,256	0.009	126,716	0.009
Roll	108,357	0.401	313,614	0.396	113,500	0.363

Note(s): *Panel A* reports the number of firm-year observations, the number of individual mergers, as well as the number of single acquirers. *Panel B* reports the characteristics of the deals. *Panel C* reports the summary statistics of the control variables per deal and the IAMs on a firm-day basis, as percentages. *Panel D* reports the summary statistics of the IAMs on a firm-day basis, as percentages, broken down by periods of observation. Column 1 reports summary statistics of the IAMs during the pre-announcement period. Column 2 reports summary statistics of the IAMs during the negotiation period. Column 3 reports the summary statistics of the IAMs during the post-completion period

Table 1.
Sample statistics

observations. There are 582 individual acquirers, indicating the presence of serial acquirers. Overlapping acquisitions can be problematic from an econometric standpoint. We address the serial acquirer concern in the robustness section by showing that our results are qualitatively similar when we remove overlapping acquisitions.

Panel B reports the characteristics of the deals in our sample. Our sample is roughly split between private target and public targets, each representing over 45% of the sample. Targets that are subsidiaries represent about 9% of the sample. A large majority of the deals are mergers (86%), while the remaining 14% are acquisitions. The overwhelming majority of the deals in our sample are friendly M&As; only 1% of the deals are hostile [10]. The M&As in our sample also vary in the method of payment. Approximately 47% are all-stock deals, 15% are all-cash deals, while the remaining acquisitions are paid for with a mix of cash and stock.

Panel C presents sample summary statistics. The average bank engaging in an M&A has assets of about US$24bn. The median size of US$4.6bn and the high standard deviation suggest that some large entities have been M&A-active. The average book-to-market ratio is 0.675, indicating that M&A-active banks tend to be more highly valued by the market. The average debt-to-equity ratio is 1.718, with a median value of 1.407, while the average bank's income is about 1.2% of the lagged assets. Panel C also reports the means, medians and standard deviations of our six measures of IA.

The statistics are consistent with past literature. For example, the sample in Chordia *et al.* (2000) has a mean (median) *PQ spread* value of 0.016 (0.011) and a mean (median) *Effective spread* of 0.225 (0.179), similar to our corresponding mean (median) values of 0.015 (0.09) and 0.242 (0.125).

5. Results

5.1 Initial results

The coefficient on the *Period of interest* variable captures the direction and the magnitude of the change in IA between any two periods of observation. For each pairwise test, the coefficient reported is that of the latest period compared to the preceding one. For example, in our first pairwise test between the pre-announcement period 1 and the negotiation period 2, the coefficient reported is that of the *Negotiation* indicator variable. This setting makes the interpretation of the coefficient simple as a positive (negative) coefficient implies an increase (decrease) in opacity immediately following the announcement of deal.

Tables 2 through 8 report the coefficients of the variable of interest, *Period of interest*. In each table, the first column reports the results of our regression comparing the pre-announcement period 1 to the negotiation period 2. In this setting, we report the coefficient of the *Negotiation* variable. The second column reports the results of our regression comparing the negotiation period 2 to the post-completion period 3. In this setting, we report the coefficient of the *Post-Completion* variable, which allows us to investigate changes to the information environment following the completion of a deal. Finally, the third column reports the results of our regression comparing the pre-announcement period 1 to the post-completion period 3. For this test, we report the coefficient of the *Post-Completion* variable, which allows us to investigate whether IA reverts to its pre-announcement level following the completion of a deal.

We compute the IAMs such that a *positive* coefficient implies an *increase* in IA from one period to the next, and a *negative* coefficient implies a *decrease* in IA (the coefficients are percentage changes).

Table 2 reports the results of our setting for the full sample (for brevity's sake, we do not report the coefficients of the control variables). Evidence regarding the impact of deal announcement is mixed. The six IAMs have positive point estimates, but only *PE spread* and *HL spread* are statistically significant at conventional levels, offering modest evidence of an increase in IA following announcement of a deal.

Table 2.
Acquire information environment through the M&A process

IAMs	Negotiation	(1) v (2) *T*-stat	Adjusted R^2	Post-comp	(2) v (3) *T*-stat	Adjusted R^2	Post-comp	(1) v (3) *T*-stat	Adjusted R^2
Daily spread	0.707	1.53	5.26%	−1.978***	−4.55	6.23%	−1.331**	−2.39	5.15%
PQ spread	0.038	1.59	22.77%	−0.101***	−4.49	23.62%	−0.065**	−2.29	23.06%
Effective Spread	0.524	1.28	5.40%	−1.493***	−4.07	6.52%	−0.989**	−2.04	5.87%
PE spread	0.031**	2.28	14.26%	−0.040***	−3.17	15.22%	−0.012	−0.74	14.86%
HL spread	0.018*	1.66	9.68%	−0.015	−1.44	9.96%	0.000	−0.02	8.56%
Roll	0.749	1.07	8.50%	−2.836***	−4.31	9.30%	−2.167**	−2.57	8.16%

Note(s): *T*-statistics in parentheses. ***, ** and * denote significance of coefficients at the 1, 5 and 10% levels, respectively

We estimate six proxies of IA following the method employed by Haggard *et al.* (2015) and Chordia *et al.* (2000) for a period going from 42 days prior the announcement date of a merger to 42 days following the date the merger is effective. We run the following OLS regression model (1): $\text{IAM}_{i,t} = \beta_0 + \beta_1 \text{Period of interest}_{j,t} + \gamma_1 \text{Deal} - \text{level Controls}_{i,j} + \gamma_2 \text{Firm} - \text{level Controls}_{i,y-1}$

where the dependent variable *IAM* represents any of our information asymmetry measures; *Period of interest* represents the indicator variable *Negotiation,* which equals 1 for all observations that occur between the announcement and completion of a deal, 0 otherwise, or the indicator variable *Post-completion,* which equals 1 for all observations that occur after the date the merger is effective, 0 otherwise. The vector of *deal-level control* variables includes *transaction value,* an indicator variable capturing the *type* of the merger, the *nature* of the deal, a *tender* indicator and *the method of payment.* We include *book to market*, *debt to equity*, *total assets and income scaled by lagged total assets* as firm-level controls. We cluster all standard errors by firm and year-month. For clarity, we do not report the coefficients on controls. All variables are defined in Appendix

The following measures follow Haggard *et al.* (2015) and Chordia *et al.* (2000). The coefficients of our market measures are reported in percent. We calculate *Daily spread* as the mean daily difference between the day's high and low trading price divided by the closing price. *PQ spread* is computed as the difference between the bid and ask prices divided by half the bid plus the ask price. *Effective spread* is calculated as twice the absolute value of the price minus the bid–ask midpoint. *PE spread* is computed as twice the absolute value of the price minus the bid–ask midpoint scaled by price. *PQ spread, Effective spread* and *PE spread* are calculated in accordance with Chordia *et al.* (2000). *HL spread* is the daily mean of the estimated effective spread calculated in accordance with Corwin and Shultz (2012). *Roll* is the daily estimated spread estimated by the covariance in prices calculated in accordance with Roll (1984). For readability, all coefficients are scaled by a factor of 100

Table 3.
Target ownership status

IAMs	Period 1 vs Period 2			Period 2 vs Period 3			Period 1 vs Period 3		
	Negotiation	*T*-statistic	Adjusted R^2	Post-comp	*T*-statistic	Adjusted R^2	Post-comp	*T*-statistic	Adjusted R^2
Panel A: Public target									
Daily spread	−0.034	−0.05	3.74%	−1.318**	−2.25	4.10%	−1.456*	−1.89	3.23%
PQ spread	0.024	0.75	20.36%	−0.089***	−3.16	18.94%	−0.072**	−1.98	18.62%
Effective spread	−0.382	−0.63	4.37%	−1.304***	−2.58	5.15%	−1.756**	−2.46	4.23%
PE spread	0.017	0.98	15.45%	−0.032*	−1.92	15.46%	−0.017	−0.80	15.24%
HL spread	0.010	0.73	9.24%	0.005	0.38	8.32%	0.013	0.76	7.34%
Roll	−0.474	−0.47	5.14%	−2.269**	−2.46	5.11%	−2.959**	−2.43	4.17%
Panel B: Private target									
Daily spread	1.214*	1.73	9.13%	−2.816***	−3.99	9.23%	−1.656*	−1.88	8.16%
PQ spread	0.049	1.21	28.85%	−0.115***	−3.07	28.51%	−0.067	−1.38	26.94%
Effective spread	1.311**	2.13	7.73%	−1.956***	−3.38	7.94%	−0.629	−0.86	7.88%
PE spread	0.046**	2.15	14.63%	−0.054***	−2.63	14.91%	−0.009	−0.33	14.77%
HL spread	0.038**	1.99	12.69%	−0.047***	−2.57	11.94%	−0.013	−0.58	10.48%
Roll	1.685*	1.79	15.76%	−3.597***	−3.46	15.23%	−1.951	−1.51	14.58%
Panel C: Subsidiary target									
Daily spread	1.782	1.26	8.57%	−2.039	−1.63	8.65%	−0.196	−0.12	5.43%
PQ spread	0.036	0.46	24.40%	−0.103	−1.45	24.15%	−0.063	−0.74	27.16%
Effective spread	1.293	1.19	8.72%	−0.998	−0.98	7.67%	0.251	0.21	8.83%
PE spread	0.012	0.29	14.12%	−0.037	−0.97	14.92%	−0.027	−0.59	14.98%
HL spread	−0.027	−0.71	7.52%	0.018	0.51	7.51%	−0.006	−0.14	5.83%
Roll	1.646	0.78	14.87%	−2.701	−1.52	14.81%	−0.825	−0.36	15.91%

Note(s): *T*-statistics in parentheses. ***, ** and * denote significance of coefficients at the 1, 5 and 10% levels, respectively

We split our sample into three sub-samples: Public target (*Panel A*), Private target (*Panel B*) and Subsidiary target (*Panel C*) depending on the nature of the target ownership. We run the following OLS regression model (1): $IAM_{i,t} = \beta_0 + \beta_1 \text{Period of interest}_{j,t} + \gamma_1 \text{Deal} - \text{level Controls}_{i,j} + \gamma_2 \text{Firm} - \text{level Controls}_{i,y-1}$ where the dependent variable *IAM* represents any of our information asymmetry measures; *Period of interest* represents the indicator variable *Negotiation,* which equals 1 for all observations that occur between the announcement and completion of a deal, 0 otherwise, or the indicator variable *Post-completion,* which equals 1 for all observations that occur after the date the merger is effective, 0 otherwise. The vector of *deal-level control* variables includes *transaction value*, an indicator variable capturing the *type* of the merger, the *nature* of the deal, a *tender* indicator and *the method of payment*. We include *book to market*, *debt to equity*, *total assets and income scaled by lagged total assets* as firm-level controls. We cluster all standard errors by firm and year-month. For clarity, we do not report the coefficients on controls. All variables are defined in Appendix

The following measures follow Haggard *et al.* (2015) and Chordia *et al.* (2000). The coefficients of our market measures are reported in percent. We calculate *Daily spread* as the mean daily difference between the day's high and low trading price divided by the closing price. *PQ spread* is computed as the difference between the bid and ask prices divided by half the bid plus the ask price. *Effective spread* is calculated as twice the absolute value of the price minus the bid–ask midpoint. *PE spread* is computed as twice the absolute value of the price minus the bid–ask midpoint scaled by price. *PQ spread, Effective spread* and *PE spread* are calculated in accordance with Chordia *et al.* (2000). *HL spread* is the daily mean of the estimated effective spread calculated in accordance with Corwin and Shultz (2012). *Roll* is the daily estimated spread estimated by the covariance in prices calculated in accordance with Roll (1984). For readability, all coefficients are scaled by a factor of 100

Table 4.
Deal type

Panel A: Type of deal per target status Deal type/target status	Merger		Acquisition of assets					
	Number		%			Number		%
Private	1,211		44.72			238		54.34
Public	1,409		52.03			15		3.42
Subsidiary	88		3.25			185		42.24
Total	2,708		100			438		100
Panel B: Mergers								
Daily spread	0.439	0.89	6.27%	−1.793***	−3.84	6.45%	−1.413**	−2.32	5.52%
PQ spread	0.039*	1.68	24.66%	−0.100***	−4.24	23.97%	−0.064**	−2.09	23.28%
Effective spread	0.340	0.76	5.89%	−1.606***	−4.05	6.52%	−1.288**	−2.38	5.87%
PE spread	0.031**	2.19	15.64%	−0.043***	−3.16	15.83%	−0.012	−0.72	15.48%
HL spread	0.024**	2.05	10.94%	−0.016	−1.45	10.20%	0.005	0.36	9.09%
Roll	0.486	0.64	9.13%	−2.825***	−4.00	9.11%	−2.440***	−2.66	7.98%
Panel C: Acquisitions								
Daily spread	2.813**	2.43	5.34%	−3.609***	−3.19	5.72%	−0.753	−0.58	3.76%
PQ spread	0.064	0.97	24.67%	−0.123*	−1.80	23.18%	−0.061	−0.80	23.92%
Effective spread	2.058**	2.38	6.48%	−0.989	−1.07	6.39%	1.009	0.99	6.19%
PE spread	0.041	1.30	12.48%	−0.036	−1.07	12.25%	0.003	0.09	12.61%
HL spread	0.004	0.13	9.00%	−0.031	−0.93	8.25%	−0.024	−0.68	6.96%
Roll	2.736	1.51	12.37%	−3.200	−1.56	11.80%	−0.438	−0.21	11.83%

Note(s): *T*-statistics in parentheses. ***, ** and * denote significance of coefficients at the 1, 5 and 10% levels, respectively. Haggard *et al.* (2015) and Chordia *et al.* (2000). The coefficients of our market measures are reported in percent. We calculate *Daily spread* as the mean daily difference between the day's high and low trading price divided by the closing price. *PQ spread* is computed as the difference between the bid and ask prices divided by half the bid plus the ask price. *Effective spread* is calculated as twice the absolute value of the price minus the bid–ask midpoint. *PE spread* is computed as twice the absolute value of the price minus the bid–ask midpoint scaled by price. *PQ spread, Effective spread* and *PE spread* are calculated in accordance with Chordia *et al.* (2000). *HL spread* is the daily mean of the estimated effective spread calculated in accordance with Corwin and Shultz (2012). For readability, all coefficients are scaled by a factor of 100

Table 5.
Deal nature

IAMs	Period 1 vs Period 2 Negotiation	*T*-statistic	Adjusted R^2	Period 2 vs Period 3 Post-comp	*T*-statistic	Adjusted R^2	Period 1 vs Period 3 Post-comp	*T*-statistic	Adjusted R^2
Daily spread	−4.220	−1.58	40.74%	3.036	1.52	48.88%	1.805	0.75	30.63%
PQ spread	−0.033	−0.43	78.22%	0.024	0.55	81.98%	0.090	0.86	77.11%
Effective spread	0.909	0.63	29.93%	−0.651	−0.57	34.23%	1.004	0.54	26.28%
PE spread	0.089	1.35	46.42%	−0.061	−1.54	50.21%	0.044	0.47	44.14%
HL spread	−0.001	−0.02	18.41%	−0.030	−0.69	30.81%	0.053	0.77	29.17%
Roll	−8.165**	−2.09	46.58%	4.661	1.62	59.39%	1.812	0.64	43.84%

Note(s): *T*-statistics in parentheses. ***, ** and * denote significance of coefficients at the 1, 5 and 10% levels, respectively

We look at the impact of hostile deals on the information environment. We run the following OLS regression model (1): $\text{IAM}_{i,t} = \beta_0 + \beta_1 \text{Period of interest}_{j,t} + \gamma_1 \text{Deal} - \text{level Controls}_{i,j} + \gamma_2 \text{Firm} - \text{level Controls}_{i,y-1}$

where the dependent variable *IAM* represents any of our information asymmetry measures; *Period of interest* represents the indicator variable *Negotiation,* which equals 1 for all observations that occur between the announcement and completion of a deal, 0 otherwise, or the indicator variable *Post-completion,* which equals 1 for all observations that occur after the date the merger is effective, 0 otherwise. The vector of *deal-level control* variables includes *transaction value*, an indicator variable capturing the *type* of the merger, the *nature* of the deal, a *tender* indicator and *the method of payment*. We include *book to market*, *debt to equity*, *total assets and income scaled by lagged total assets* as firm-level controls. We cluster all standard errors by firm and year-month. For clarity, we do not report the coefficients on controls. All variables are defined in Appendix

The following measures follow Haggard *et al.* (2015) and Chordia *et al.* (2000). The coefficients of our market measures are reported in percent. We calculate *Daily spread* as the mean daily difference between the day's high and low trading price divided by the closing price. *PQ spread* is computed as the difference between the bid and ask prices divided by half the bid plus the ask price. *Effective spread* is calculated as twice the absolute value of the price minus the bid–ask midpoint. *PE spread* is computed as twice the absolute value of the price minus the bid–ask midpoint scaled by price. *PQ spread, Effective spread* and *PE spread* are calculated in accordance with Chordia *et al.* (2000). *HL spread* is the daily mean of the estimated effective spread calculated in accordance with Corwin and Shultz (2012). *Roll* is the daily estimated spread estimated by the covariance in prices calculated in accordance with Roll (1984). For readability, all coefficients are scaled by a factor of 100

Table 6. Method of payment

IAMs	Negotiation	Period 1 vs Period 2 *T*-statistic	Adjusted R^2	Post-comp	Period 2 vs Period 3 *T*-statistic	Adjusted R^2	Post-comp	Period 1 vs Period 3 *T*-statistic	Adjusted R^2
Panel A: All-stock deals									
Daily spread	−0.052	−0.09	10.64%	−1.306**	−2.20	9.95%	−1.414*	−1.89	9.41%
PQ spread	0.011	0.32	30.36%	−0.066**	−2.15	29.97%	−0.058	−1.44	27.77%
Effective spread	−0.065	−0.13	10.89%	−1.318***	−2.80	11.06%	−1.394**	−2.32	10.95%
PE spread	0.010	0.51	18.75%	−0.024	−1.40	19.11%	−0.015	−0.68	18.62%
HL spread	0.016	1.02	13.66%	−0.008	−0.51	12.66%	0.004	0.19	11.23%
Roll	−0.097	−0.11	16.89%	−2.274***	−2.63	15.86%	−2.498**	−2.29	14.93%
IAMs	Negotiation	Period 1 vs Period 2 *T*-statistic	Adjusted R^2	Post-comp	Period 2 vs Period 3 *T*-statistic	Adjusted R^2	Post-comp	Period 1 vs Period 3 *T*-statistic	Adjusted R^2
Panel B: All-cash deals									
Daily spread	2.853***	2.76	4.26%	−3.785***	−3.66	4.23%	−0.921	−0.77	2.62%
PQ spread	0.086	1.48	21.75%	−0.125**	−2.06	20.34%	−0.047	−0.66	21.06%
Effective spread	2.168**	2.54	5.12%	−1.939**	−2.20	5.35%	0.273	0.27	4.52%
PE spread	0.066**	2.17	12.71%	−0.067**	−2.12	12.46%	−0.003	−0.09	12.31%
HL spread	0.089***	3.15	9.41%	−0.098***	−3.50	8.69%	−0.014	−0.46	7.37%
Roll	3.280**	2.09	7.99%	−3.734**	−2.29	7.68%	−0.397	−0.21	7.46%
Panel C: Mixed payment deals									
Daily spread	0.632	0.72	4.07%	−1.810**	−2.51	5.40%	−1.114	−1.11	3.65%
PQ spread	0.052	1.44	21.42%	−0.128**	−3.83	20.65%	−0.073*	−1.77	21.94%
Effective spread	0.482	0.57	2.79%	−1.323**	−1.97	3.99%	−0.785	−0.83	3.03%
PE spread	0.042**	2.17	13.14%	−0.043**	−2.27	13.34%	−0.002	−0.08	13.24%
HL spread	−0.007	−0.43	6.60%	0.012	0.81	6.22%	0.007	0.35	5.32%
Roll	0.532	0.39	5.01%	−2.775**	−2.37	6.14%	−2.115	−1.35	4.63%

Note(s): *T*-statistics in parentheses. ***, ** and * denote significance of coefficients at the 1, 5 and 10% levels, respectively

We split our sample into two sub-samples: All-cash acquisitions (*Panel A*) and All-stock acquisitions (*Panel B*), depending on the method of payment used to conclude the deal. We run the following OLS regression model (1): $IAM_{i,t} = \beta_0 + \beta_1 \text{Period of interest}_{j,t} + \gamma_1 \text{Deal} - \text{level Controls}_{i,j} + \gamma_2 \text{Firm} - \text{level Controls}_{i,y-1}$

where the dependent variable *IAM* represents any of our information asymmetry measures; *Period of interest* represents the indicator variable *Negotiation,* which equals 1 for all observations that occur between the announcement and completion of a deal, 0 otherwise, or the indicator variable *Post-completion,* which equals 1 for all observations that occur after the date the merger is effective, 0 otherwise. The vector of *deal-level control* variables includes *transaction value*, an indicator variable capturing the *type* of the merger, the *nature* of the deal, a *tender* indicator and *the method of payment*. We include *book to market*, *debt to equity*, *total assets and income scaled by lagged total assets* as firm-level controls. We cluster all standard errors by firm and year-month. For clarity, we do not report the coefficients on controls. All variables are defined in Appendix

The following measures follow Haggard *et al.* (2015) and Chordia *et al.* (2000). The coefficients of our market measures are reported in percent. We calculate *Daily spread* as the mean daily difference between the day's high and low trading price divided by the closing price. *PQ spread* is computed as the difference between the bid and ask prices divided by half the bid plus the ask price. *Effective spread* is calculated as twice the absolute value of the price minus the bid–ask midpoint. *PE spread* is computed as twice the absolute value of the price minus the bid–ask midpoint scaled by price. *PQ spread, Effective spread* and *PE spread* are calculated in accordance with Chordia *et al.* (2000). *HL spread* is the daily mean of the estimated effective spread calculated in accordance with Corwin and Shultz (2012). *Roll* is the daily estimated spread estimated by the covariance in prices calculated in accordance with Roll (1984). For readability, all coefficients are scaled by a factor of 100

Table 7.
Information environment through the M&A process – long-term impact

Pre-announcement period 1 vs post-completion period 3 over various timelines								
	42 days		6 months		1 year		2 years	
IAMs	Coefficient	*T*-statistic	Coefficient	*T*-statistic	Coefficient	*T*-statistic	Coefficient	*T*-statistic
Daily spread	−1.331**	−2.39	−0.920***	−2.72	−1.326***	−3.84	−2.18***	−5.75
PQ spread	−0.065**	−2.29	−0.049***	−4.07	−0.073***	−5.68	−0.116***	−8.23
Effective spread	−0.989**	−2.04	−0.937***	−4.91	−1.361***	−6.76	−2.013***	−8.87
PE spread	−0.012	−0.74	−0.030***	−3.94	−0.046***	−5.70	−0.067***	−7.46
HL spread	0.000	−0.02	−0.020**	−2.31	−0.020**	−2.24	−0.021**	−2.17
Roll	−2.167**	−2.57	−1.452***	−4.86	−2.096***	−6.16	−3.21***	−10.52

Note(s): We estimate six proxies of IA following the method employed by Haggard *et al.* (2015) and Chordia *et al.* (2000) comparing the pre-announcement date 1 to the long-term post-completion effect 3 by looking at several periods ranging from 42 days to 2 years following the date the merger is effective. We run the following OLS regression model (1): $\mathrm{IAM}_{i,t} = \beta 0 + \beta 1\ \mathrm{Period\ of\ interest}_{j,t} + \gamma 1\ \mathrm{Deal} - \mathrm{level\ Controls}_{i,j} + \gamma 2\ \mathrm{Firm} - \mathrm{level\ Controls}_{i,y-1}$
where the dependent variable *IAM* represents any of our information asymmetry measures; *Period of interest* represents the indicator variable *Negotiation,* which equals 1 for all observations that occur between the announcement and completion of a deal, 0 otherwise, or the indicator variable *Post-completion,* which equals 1 for all observations that occur after the date the merger is effective, 0 otherwise. The vector of *deal-level control* variables includes *transaction value*, an indicator variable capturing the *type* of the merger, the *nature* of the deal, a *tender* indicator and *the method of payment*. We include *book to market*, *debt to equity*, *total assets and income scaled by lagged total assets* as firm-level controls. We cluster all standard errors by firm and year-month. For clarity, we do not report the coefficients on controls. All variables are defined in Appendix
The following measures follow Haggard *et al.* (2015) and Chordia *et al.* (2000). The coefficients of our market measures are reported in percent. We calculate *Daily spread* as the mean daily difference between the day's high and low trading price divided by the closing price. *PQ spread* is computed as the difference between the bid and ask prices divided by half the bid plus the ask price. *Effective spread* is calculated as twice the absolute value of the price minus the bid–ask midpoint. *PE spread* is computed as twice the absolute value of the price minus the bid–ask midpoint scaled by price. *PQ spread, Effective spread* and *PE spread* are calculated in accordance with Chordia *et al.* (2000). *HL spread* is the daily mean of the estimated effective spread calculated in accordance with Corwin and Shultz (2012). *Roll* is the daily estimated spread estimated by the covariance in prices calculated in accordance with Roll (1984). For readability, all coefficients are scaled by a factor of 100

Table 8. Target information environment through the M&A process

Pre-announcement period 1 vs negotiation period 2 – Targets

	All-deals		All-stock		Mixed payments		All-cash	
IAMs	Coefficient	*T*-statistic	Coefficient	*T*-statistic	Coefficient	*T*-statistic	Coefficient	*T*-statistic
Daily spread	−9.224***	−5.55	−9.881***	−3.92	−5.128***	−3.42	−25.611***	−3.78
PQ spread	−0.875***	−6.07	−0.662***	−3.75	−0.757***	−3.76	−2.743***	−4.76
Effective spread	−1.895*	−1.71	−0.740	−0.41	−2.343*	−1.72	−11.377***	−5.49
PE spread	−0.434***	−6.68	−0.421***	−4.76	−0.310***	−3.88	−0.919***	−5.03
HL spread	−0.049***	−7.60	−0.053***	−5.83	−0.032***	−4.30	−0.065**	−2.03
Roll	−2.499	−0.87	−4.154	−0.95	−7.076**	−3.04	−37.036***	−3.86

Note(s): *T*-statistics in parentheses. ***, ** and * denote significance of coefficients at the 1, 5 and 10% levels, respectively

This test investigates the evolution of the information environment of the target throughout the merger process. We only focus on the change in the pre-announcement period 1 to the negotiation period 2. In a merger, targets are outright absorbed by acquirers, and as a result, simply cease to exist following deal completion. As such, there is no post-completion period 3 for merger targets. As mergers represent 99% of the deals involving public targets, we simply discard the 1% of the deals (15 deals) that are acquisitions (and would as such have a post-completion period 3). We run the following OLS regression model (1): $IAM_{i,t} = \beta 0 + \beta 1\text{Post} - \text{completion}_{j,t} + \beta 1\text{Deal} - \text{level Controls}_{i,j} + \beta 2\text{Acquirer} - \text{level Controls}_{i,y-1} + \text{Target} - \text{level Controls}_{i,y-1}$

where the dependent variable *IAM* represents any of our information asymmetry measures; *Period of interest* represents the indicator variable *Negotiation,* which equals 1 for all observations that occur between the announcement and completion of a deal, 0 otherwise, or the indicator variable *Post-failure,* which equals 1 for all observations that occur after the date the merger is effective, 0 otherwise. The vector of *deal-level control* variables includes *transaction value*, an indicator variable capturing the *type* of the merger, the *nature* of the deal, a *tender* indicator and *the method of payment*. We include *book to market, debt to equity, total assets and income scaled by lagged total assets* as acquirer and target-level controls. We cluster all standard errors by firm and year-month. For clarity, we do not report the coefficients on controls. All variables are defined in Appendix

The measures follow Haggard *et al.* (2015) and Chordia *et al.* (2000). The coefficients of our market measures are reported in percent. We calculate *Daily spread* as the mean daily difference between the day's high and low trading price divided by the closing price. *PQ spread* is computed as the difference between the bid and ask prices divided by half the bid plus the ask price. *Effective spread* is calculated as twice the absolute value of the price minus the bid–ask midpoint. *PE spread* is computed as twice the absolute value of the price minus the bid–ask midpoint scaled by price. *PQ spread, Effective spread* and *PE spread* are calculated in accordance with Chordia *et al.* (2000). *HL spread* is the daily mean of the estimated effective spread calculated in accordance with Corwin and Shultz (2012). *Roll* is the daily estimated spread estimated by the covariance in prices calculated in accordance with Roll (1984). All coefficients are scaled by a factor of 100

The second column reports the coefficient of the IAMs comparing the negotiation period to the post-completion period (2 vs 3). Five out of six IAMs significantly point toward a reduction in IA following the completion of a merger (only *HL spread* is insignificant). For example, *Daily spread* and *Roll* decrease by 1.9 and 2.8 basis points, respectively, in the post-completion period compared to the negotiation period.

The finding of the second column are consistent with a decline in IA following deal completion. However, it does not provide further clues as to whether the IA level reverts to *ex ante* levels following completion (i.e. back to pre-announcement levels). The third column addresses this question by reporting the coefficients of the IAMs comparing the pre-announcement period to the post-completion period (1 vs 3). Four out of our six IAMs are significantly negative, evidence that IA declines to lower levels in the post-completion period compared to pre-announcement levels. The magnitudes of the IAMs are lower than in the second column, confirming the idea of a possible increase in IA following the announcement of a deal, followed by an even greater decrease in IA once the deal is completed.

In sum, the first set of tests suggests that the announcement of a merger increases IA and confirms that the subsequent completion of a merger decreases IA below pre-announcement levels, which is consistent with our H1.

5.2 Public, private and subsidiary targets

We now investigate whether the magnitudes of the reported changes in IA are influenced by deal characteristics. For example, the quality of the information about the target available to investors is likely to influence the information environment through the M&A process. To investigate this possibility, we look at the type of target as a proxy for the quantity and quality of information available to investors. We decompose our sample into three subsamples: (1) public targets, (2) private targets and (3) subsidiaries.

Panel A of Table 3 reports the results of the regressions for the public target sub-sample. We do not find evidence of any change in IA following the announcement of a deal as none of the IAMs is significant. Our interpretation is that because public firms are more visible, with information more easily accessible to investors and as a consequence, there is no significant change in our IA following the announcement of a deal. The next two columns present coefficients that are similar to those observed in the full sample: a decrease in IA once the merger is effective that leads to lower IA level post-completion than pre-announcement, consistent with the notion that the additional release of information "cleared the air."

Panel B presents the results for the private target subsample. The first column shows that the announcement of a deal involving a private target significantly increases the levels of IA. Five out of six IAMs are statistically significant, with a greater magnitude than in the full sample or in the public target sample. We conclude that much of the increase in IA detected following the announcement of a merger comes from mergers involving private targets, consistent with our H2.

The results for the post-completion period in the second column are unambiguous as well. All IAMs indicate a decrease in opacity following the completion of a merger involving a private target. Every IAM is significant, some with magnitudes about twice as large as that of the public sample. For example, *Effective spread* decreases by 2 basis points and *Roll* is lower by 3.6 basis points. The decreases are significant, given their respective means of 0.24 and 0.39. Only one IAM is significant in the third column, with results that are less pronounced than for public firms. The results suggest that the information environment reverts to pre-announcement levels following completion. We conclude that M&A deals involving private targets temporarily increase opacity, but that IA levels revert to their normal levels following the completion of the deal.

Panel C reports the results for the sample with targets that are subsidiaries. The subsidiaries of our sample are, by definition, firms whose voting rights are controlled by a

parent firm [11]. The results suggest that the change in the level of IA is insignificant for the subsidiaries sample. All of the coefficients are statistically indistinguishable from zero, regardless of the period observed. We interpret these results as consistent with the notion that there is less uncertainty when acquirers acquire targets with which they are already familiar, hence the lack of change in the information environment during the M&A process.

Overall, our findings suggest that M&As involving private targets trigger significant changes in IA throughout the M&A process, that M&A involving public targets tend to decrease IA levels in the long run and M&A involving subsidiary targets do not affect IA levels. We conclude that the magnitude of changes in IA during an M&A is significantly influenced by target characteristics.

5.3 Merger vs acquisitions

We next test whether the type of deal observed similarly impacts IA levels during the M&A process. In a merger, the acquirer outright absorbs a target, thus facing significant integration costs. We posit that there might be greater changes in IA surrounding a merger than there are for an acquisition, which involves fewer, less complex steps.

Panel A of Table 4 reports the types of firms targeted for each deal type. The merger sample resembles the full sample: every type of target is proportionately represented, except for subsidiaries, which are underrepresented. This pattern is reversed in the acquisition sample as subsidiaries represent almost half of the sample, with public targets accounting for only 3% of all acquisitions.

Panel B reports the coefficients for the sample of merger deals. In the first column, the results are consistent with that of the full sample in terms of magnitudes; three IAMs are significant, offering evidence of a modest increase in IA. The results in the second and third columns are also consistent with the results of the full sample, suggesting that IA decreases significantly following the conclusion of a deal below its pre-announcement levels.

Panel C reports the results for the acquisitions sample. There is only weak evidence of an impact of the M&A process on IA. We find modest evidence of increase in IA in the negotiation period followed by mild evidence of a decrease in opacity in the post-completion period. Our IAMs capture some variation, although they do not all point in the same direction and are, on average, less significant. We interpret these results as consistent with acquisitions influencing the information environment less than mergers.

5.4 Hostile versus friendly deals

We investigate whether changes in the information environment differ between hostile and friendly deals. There are few hostile deals (a total of 33 in our sample); Table 5 reports the result of our regression for hostile deals. We find no evidence of changes in IA associated with hostile M&As. The IAMs are inconsistent in their point estimates and with only one exception, none of them is significant. The small sample size at least partly explains the insignificant coefficients.

5.5 Method of payment

We now look at whether the choice of the method of payment influences changes in IA over the M&A process. Specifically, we look at the stock-only, cash-only and mixed-payment deals. *Panel A* of Table 6 reports the results of our regressions for the all-stock deals in our sample, about 47% of all deals.

The first observation is that there is no change associated with the announcement of an all-stock deal. Past literature suggests an explanation for this finding: all-stock offers are seen as less risky for the bidder, especially when acquiring volatile targets (Officer *et al.*, 2008), as they allow the acquirer to share overvaluation risk with the target. The risk sharing is

important because overvaluation is one of the principal risks associated with M&As (Rhodes-Kropf and Viswanathan, 2004).

The coefficients in the second column are similar to those of the full sample, with evidence of a decrease in IA following deal completion, as four out of six IAMs significantly point in that direction. Similarly, the results reported in the third column comparing the pre-announcement period and the post-completion period suggest that IA decreases even beyond pre-announcement level following deal completion. In sum, results for all-stock deals indicate that the announcement of a deal paid for with only equity has little influence on IA, but that the completion of such a deal does.

On the other end of the method of payment spectrum, *panel B* presents the results for all-cash deals. All-cash deals are less common and represent about 15% of our sample. The coefficients on the *Negotiation* variable suggest that IA increases significantly following the announcement of an all-cash deal. *Daily spread* is higher by 2.9 basis points, and *Roll* increases by 3.2 basis points in the negotiation period. The magnitude of all coefficients is even higher than for private targets, confirming that all-cash deals are a significant driver of our initial result of an increase in IA following the announcement of a deal. Similarly, we observe a commensurate decrease in IA of a similar magnitude following the completion of all-cash deals, bringing back IA levels to their pre-announcement level.

Panel C presents the results of our tests for mixed payments, which account for the remaining 48% of the sample. We find a decrease in IA following the completion of a deal compared to the negotiation period. The magnitude of the coefficients and their significance are roughly between that of all-cash and all-stock deals in all instances, and a linear increase (decrease) can be observed from one panel to the next.

We conclude that the method of payment of a deal influences the magnitude of the changes in IA during the takeover process. All-cash deals influence IA around both the announcement date and the competition date, making the transition period a particularly high level of IA. By contrast, all-stock deals appear to influence the information environment primarily around the conclusion of the deal, as there is scant evidence of any change around the announcement of these deals.

5.6 Window of observation and long-term impact

The length of the window of observation determines how far back (and forward) we go to analyze the changes in the information environment. In our baseline regressions, we use a window of 42 trading days before the announcement date, as it is commonly referred to in the M&A announcement return literature as the length of the "run-up" period, and 42 trading days after the effective date to have a balanced setting (see Schwert, 1996; Betton *et al.*, 2009) [12].

Still, the question of whether the long-term effect of M&As on IA is transient or permanent remains. Table 7 reports the results of our main test using longer windows of observation of six months, one year and two years. The magnitude of the coefficients is consistent across columns. If anything, the magnitude of the coefficients increases using the two-year window. Although we are cautious with our interpretation because the potential for confounding events increases with longer windows of observation, these results suggest that the long-term impact of M&A on IA is permanent. This finding contrasts with that of Haggard *et al.* (2015) who find that changes in IA following an accounting bath are transient, as they revert back after two years.

5.7 Target information asymmetry

Table 8 reports the results of our information environment tests applied to public targets (the only target type with available equity market data) [13]. In a merger, targets are outright

absorbed by acquirers, and as a result, simply cease to exist following deal completion. As such, there is no post-completion period 3 for merger targets. As mergers represent 99% of deals involving public targets, we simply discard the remaining 1% that are acquisitions (15 deals). Consequently, we only focus on the change from the pre-announcement period 1 to the negotiation period 2.

For targets, the change in IA following deal announcement goes in the opposite direction to that of acquirers. In every setting tested, there is a significant decrease in IA during the negotiation period. This finding is intuitive and consistent with the literature's finding on target announcement returns, as in most cases, targets are acquired at a significant premium. As such, being targeted is in itself information-revealing, thus reducing IA between insiders and outsiders. Looking at the impact of the method of payment (columns 2 to 4), the decrease in IA is especially strong for all-cash deals. Cash deals remove all uncertainty regarding the currency used for the acquisition, consistent with the large decrease reflected in the IAMs.

The magnitude of the coefficients is significantly higher for targets than it is for acquirers in every setting during the negotiation period. That is, although some acquirers experience an increase in IA post-announcement (depending on deal characteristics), targets experience a larger decrease in IA.

5.8 Serial acquirers

Serial acquirers are firms that complete multiple bids within a defined period. Past literature has used different criteria to define what it means to be a "serial acquirer." For example, Fuller *et al.* (2002) define serial acquirers as firms that acquire five or more firms within a three-year window. Laamanen and Keil (2008) include any firm that makes at least four acquisitions in ten years, and Aktas *et al.* (2009) consider any firm that makes at least two acquisitions within a span of 12 months to be a serial acquirer.

Serial acquirers could be problematic for our analysis if they make subsequent acquisitions in a manner that creates overlapping time periods for two (or more) M&As. To address that concern, we re-run our series of tests by eliminating any overlapping M&A activities, keeping only "uncontaminated" observations. The length of the window used to define the announcement period and the post-completion period affects the number of observations, but our (untabulated) results remain qualitatively similar for all time windows.

5.9 Merger waves

Merger waves might affect our results. To address this possibility, we run our tests controlling for the different merger waves with indicator variables. In different specifications, we control for the merger waves as defined in previous literature (Betton *et al.*, 2007) or by controlling for the years of our sample with the largest number of M&As. The (untabulated) results are qualitatively similar with the addition of these controls.

5.10 Impact of the Dodd–Frank Act

We now investigate whether changes in IA during the M&A process are different in the post-Dodd–Frank period. We create an indicator variable *Dodd–Frank* equal to 1 if an observation occurs after the enactment of the Act, and interact it with our existing indicator variables for the *period of interest*. Table 9 reports the coefficients of interest of the regression, including the indicator variable for *Dodd–Frank*, the indicator variable for the *period of interest* observed, and the interaction between the two. *Panel A* reports the results of our pairwise comparison between the pre-announcement and the negotiation period. *Panel B (Panel C)* report the results of our pairwise comparison between the negotiation and the post-completion period (pre-announcement and post-completion period).

Table 9.
Dodd–Frank Act

Pre-announcement period 1 vs negotiation period 2							
	Dodd–Frank		Negotiation period		Dodd–Frank * Negotiation period		
IAMs	Coefficient	*T*-statistic	Coefficient	*T*-statistic	Coefficient	*T*-statistic	Adjusted R^2
Daily spread	−0.273***	−12.71	0.274	0.54	−0.292	−0.49	11.09%
PQ spread	−0.014***	−11.17	0.015	0.56	0.004	0.09	28.95%
Effective spread	−0.225***	−16.15	0.139	0.31	−0.001	0	9.15%
PE spread	−0.008***	−10.79	0.019	1.39	−0.026	−0.92	18.10%
HL spread	−0.003***	−17.11	0.014	1.14	−0.011	−0.55	11.19%
Roll	−0.376***	−17.49	0.046	0.06	0.496	0.52	14.40%
Panel B: Negotiation period 2 vs post-completion period 3							
Daily spread	−0.273***	−12.74	−1.961***	−4.10	1.710***	3.06	11.40%
PQ spread	−0.013***	−15.57	−0.099***	−4.08	0.082**	2.04	28.06%
Effective spread	−0.224***	−13.05	−1.451***	−3.60	1.181**	2.29	9.98%
PE spread	−0.008***	−17.99	−0.037***	−2.75	0.034	1.39	18.25%
HL spread	−0.003***	−13.71	−0.014	−1.16	0.014	0.70	10.43%
Roll	−0.368***	−13.16	−2.78***	−3.81	2.045**	2.30	14.56%
Panel C: Pre-announcement period 1 vs post-completion period 3							
Daily spread	−0.269***	−19.58	−1.721***	−2.80	1.434**	2.00	9.41%
PQ spread	−0.013***	−19.02	−0.087***	−2.77	0.087*	1.70	27.47%
Effective spread	−0.223***	−14.30	−1.314**	−2.45	1.200*	1.78	9.01%
PE spread	−0.008***	−19.20	−0.019	−1.13	0.010	0.33	17.72%
HL spread	−0.003***	−14.22	−0.002	−0.16	0.002	0.10	8.96%
Roll	−0.372***	−15.65	−2.772***	−2.95	2.486**	2.20	12.97%

Note(s): *T*-statistics in parentheses. ***, ** and * denote significance of coefficients at the 1, 5 and 10% levels, respectively

We observe the impact of the Dodd–Frank Act on the information environment surrounding acquirers during the M&A process. We run an OLS regression on a series of variables of interest and series of control variables using the model defined in equation (2): $\mathrm{IAM}_{i,t} = \beta_0 + \beta_1 \mathrm{Dodd-Frank}_{j,t} + \beta_2\ \mathrm{Period\ of\ interest}_{j,t} + \beta_3\ \mathrm{Dodd-Frank}_{i,t}$*Period of interest$_{j,t}$ + $\gamma 1\ \mathrm{Deal-level\ Controls}_{i,j}$ + $\gamma 2\ \mathrm{Firm-level\ Controls}_{i,y-1}$ where the dependent variable *IAM* represents any of our information asymmetry measures; *Period of interest* represents the indicator variable *Negotiation,* which equals 1 for all observations that occur between the announcement and completion of a deal, 0 otherwise, or the indicator variable *Post-completion,* which equals 1 for all observations that occur after the date the merger is effective, 0 otherwise. *Dodd–Frank* is an indicator variable equal to 1 if the observation occurs after the passage of the Dodd–Frank Act, 0 otherwise, and *Dodd–Frank * Period of interest* is the interaction between *Dodd–Frank* and the *Period of interest* variables

The vector of deal-level control variables includes *transaction value*, and indicator variables capturing the *type* of the merger, the *nature* of the deal, a *tender* indicator and *the method of payment*. We include *book to market*, *debt to equity*, *total assets and income scaled by lagged total assets* as firm-level controls. We cluster all standard errors by firm and year-month. For clarity, we do not report the coefficients on controls. All variables are defined in Appendix. The measures follow Haggard *et al.* (2015) and Chordia *et al.* (2000). The coefficients of our market measures are reported in percent. We calculate *Daily spread* as the mean daily difference between the day's high and low trading price divided by the closing price. *PQ spread* is computed as the difference between the bid and ask prices divided by half the bid plus the ask price. *Effective spread* is calculated as twice the absolute value of the price minus the bid–ask midpoint. *PE spread* is computed as twice the absolute value of the price minus the bid–ask midpoint scaled by price. *PQ spread, Effective spread* and *PE spread* are calculated in accordance with Chordia *et al.* (2000). *HL spread* is the daily mean of the estimated effective spread calculated in accordance with Corwin and Shultz (2012). *Roll* is the daily estimated spread estimated by the covariance in prices calculated in accordance with Roll (1984). For readability, all coefficients are scaled by a factor of 100

The coefficients on the indicator variable for the enactment of *Dodd–Frank* are uniformly negative and significant across all panels. This pattern suggests that the passage of the law reduced overall IA. The interaction between *Dodd–Frank* and the *period of interest* provides further information the effect the law had on changes in the information environment. Most coefficients point in the opposite direction to that of the *period of interest* indicator variable, but with a lower magnitude while being statistically significant (though most interaction terms are not significant in panel A). The pattern suggests that following the enactment of Dodd–Frank, changes to the acquiring firm's information environment associated with the announcement or the completion of a deal are less pronounced than before.

In untabulated results, we run *F*-tests to see whether changes observed in the information environment following the announcement and the completion of a deal are still significant after the passage of Dodd–Frank [14]. For almost every significant IAM in the pre-Dodd–Frank era, we find evidence that their magnitude decreases following Dodd–Frank. However, some remain statistically significant, suggesting that the evidence of an increase (decrease) in opacity following the announcement (completion) of the deal weakens following the passage of the Act.

6. Conclusion

We examine changes in the information environment associated with M&As in the banking sector. Examining 3,146 M&As between 1980 and 2016, we find evidence to support the idea that the announcement and the completion of an M&A deal significantly influence acquiring firms' IA levels. We find evidence that the announcement of a deal increases IA, especially for all-cash deals and deals involving a private target. The completion of a deal decreases IA levels, sometimes even below initial pre-announcement levels. Our findings that, although the effect of deal announcement on IA levels depend on deal and target characteristics, the impact of the completion of the deal decreases IA for the majority of deals. Moreover, the observed decrease in IA is permanent as opposed to transient. We also find that targets experience a large decrease in IA following a merger announcement.

Finally, we find evidence suggesting that the passage of the Dodd–Frank Act contributed to reduced changes in IA in the banking sector. Following the enactment of the law, changes in IA following the announcement or the completion of the merger are less pronounced than before. Moreover, the passage of the law decreased overall levels of IA.

Notes

1. Frison-Roche, Marie-Anne. Asymmetry: Asymmetric Regulation/Asymmetry of Information. https://bit.ly/2BnwRbj, date not shown.
2. In 2001, there were 8,023 commercial banks; by year end 2018, there were 4,689. Source: Fred, Federal Reserve Bank of St. Louis: https://fred.stlouisfed.org/series/USNUM.
3. A merger of banks requires the approval of the new bank's primary federal regulator and, in the case of state banks, approval by its state regulator. M&A applications are also subject to comment from the Department of Justice.
4. In our sample, only 3.4% of the initial announcements report a completed deal. Deal uncertainty, thus, characterizes the period after the announcement and the appellation "negotiation period" is appropriate; the uncertainty is resolved with deal completion.
5. More realistically, there may be some informed traders active in the pre-announcement period, as suggested by price run-ups in target firms prior to merger announcements (e.g. Jarrell and Poulsen, 1989). If true, there will be a bias against finding a change in IA between the pre-announcement and the negotiating period (i.e. the bias would work against the results we find).
6. Our results are not sensitive to the choice of a 42-day window and are robust to the use of alternative lengths for the pre-announcement and post-completion periods.

7. Only 33 of the sample mergers are labeled as "Hostile" by SDC. A bid might initially be contested, but once an agreement is reached, it is typically reclassified as "Friendly." We examine whether the IA changes are different for hostile mergers, but are agnostic about how they might differ from friendly mergers.
8. https://www.sec.gov/about/laws/wallstreetreform-cpa.pdf
9. Haggard *et al.* (2015) use 11 IA measures. Data constraints prevent us from re-creating all of their measures. They use *Quoted spread* and *Effective spread* as two spread measures calculated from the TAQ database. We do not have access to the TAQ database. We adopt *PQ spread*, *Effective spread* and *PE spread* from Chordia *et al.* (2000).
10. We classify as hostile any deal reported as hostile or neutral by SDC.
11. In this study, a *subsidiary* denotes an entity with a parent owning 50% or more of its shares as per SDC. These are subsidiaries of another bank that is not the acquirer.
12. To confirm that our results are not sensitive to a specific window, we conduct our tests over different time windows (±60 days, ±25 days). In untabulated results, we find that our results are robust to such changes.
13. We run the base OLS model described in equation (1) on the subsample of public targets. The IAMs used are computed based on target-level data. We also add a vector of target control variables that includes the same characteristics used with acquirers.
14. We test whether the coefficients discussed above are collectively different from zero. A failure to reject the null hypothesis implies that following the enactment of the Dodd–Frank Act, there is no change in the information environment between the two observed periods of interest. A rejection of the null implies that the effect of the announcement (the completion) of a deal is still present, though attenuated, following the passage of Dodd–Frank.

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Further reading

Luypaert, M. and Van Caneghem, T. (2017), "Exploring the double-sided effect of information asymmetry and uncertainty in mergers and acquisitions", *Financial Management*, Vol. 46 No. 4, pp. 873-917.

Appendix

Variable	Definition
Book-to-market	Book value of assets over market value of assets
Daily spread	The mean daily difference between the day's high and low trading price divided by the closing price
Deal nature	An indicator variable equal to 1 if the deal is friendly, 0 otherwise
Deal type	An indicator variable equal to 1 if the deal is a merger, 0 otherwise
Debt to equity	Long-term debt over equity
Dodd–Frank	An indicator variable equal to 1 if the observation occurs after the passage of the Dodd–Frank Act, 0 otherwise
Effective spread	Twice the absolute value of the price minus the bid–ask midpoint
HL spread	The daily mean of the estimated effective spread calculated in accordance with Corwin and Shultz (2012)
Income scaled	Net income scaled by lagged assets
Negotiation	An indicator variable equal to 1 for all observations that occur during the negotiation period of the merger, 0 otherwise
Pct cash	The percentage of the transaction value paid for in cash
Pct stock	The percentage of the transaction value paid for with equity
PE spread	Calculated in accordance with Chordia *et al.* (2000)
PQ spread	The difference between the bid and ask prices divided by half the bid plus the ask price
Post-completion	An indicator variable equal to 1 for all observations that occur after the date the merger is effective, 0 otherwise
Post-failure	An indicator variable equal to 1 for all observations that occur after the date the merger failed, 0 otherwise (failed deal sample)
Roll	The daily estimated spread estimated by the covariance in prices calculated as in Roll (1984)
Tender	An indicator variable equal to 1 if a tender offer was used, 0 otherwise
Total assets	Total assets of the firm (in US$m)
Transaction value	The dollar value of the transaction (in US$m)

Table A1.
Variable definitions

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