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Does short-selling potential influence merger and acquisition payment choice?

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ABSTRACT

Announcements of stock-financed mergers and acquisitions (M&As) may attract short selling of bidder shares by merger arbitrageurs. We hypothesize that bidders with higher short-selling potential include a higher proportion of cash in their M&A payments to mitigate stock price declines resulting from arbitrage short sales. Consistent with this hypothesis, we find that the ex ante net lending supply of bidder shares has a positive impact on the percentage of cash in public target payments. Further tests, including a placebo analysis of public-to-private deals and an analysis of expected price pressure proxies, corroborate the impact of anticipated arbitrage-related price pressure on payment choice.

1. Introduction

Mergers and acquisitions (M&As) are among the most important events in corporate finance (Fuller et al., 2002; Hackbarth and Morellec, 2008). Announcements of M&As involving publicly-quoted targets tend to result in insignificant or positive bidder stock returns for cash-financed offers, but significant negative bidder returns for stock-financed offers (Travlos, 1987; Amihud et al., 1990; Martin, 1996; Fuller et al., 2002; Bruner, 2004; Eckbo et al., 2018).

A common explanation of this finding is that, unlike cash-financed M&A deals, stock-financed deals send a negative signal about bidder value (Travlos, 1987; Golubov et al., 2016). Mitchell et al. (2004), however, show that nearly half of the negative bidder stock price reactions to stock-financed M&A deals are due to price pressure associated with short selling by merger arbitrageurs. Merger arbitrageurs aim to profit from the difference between the bidder's offer price and the target's stock price by purchasing the target's stock immediately after an M&A announcement (Baker and Savaşoglu, 2002). In stock-financed M&As, merger arbitrageurs simultaneously eliminate their exposure to bidder stock price movements by shorting an appropriate number of bidder shares, eliciting negative stock price reactions due to an inelastic demand for the stock (Mitchell et al., 2004; Liu and Wu, 2014). In cash-financed M&As, in contrast, merger arbitrageurs have no exposure to the bidder's stock and hence no need to short sell.

In this paper, we examine the impact of a bidder's anticipated likelihood of being targeted by merger arbitrage short sellers on its M&A payment choice.[1] Bidding firms may want to avoid an arbitrage-induced announcement period stock price drop for two non-mutually ex-

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[1] We use the term "bidder" rather than "acquirer" throughout the paper since our sample includes uncompleted deals.

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clusive reasons. First, they may be concerned about the long-run negative impact of merger arbitrage on their stock price, attributable to long-run downward sloping excess demand curves for stocks (Shleifer, 1986; Lynch and Mendenhall, 1997; Duca et al., 2012). Second, they may be keen to avoid the adverse reputational effects of overly negative stock price reactions to M&A announcements, even if part of these reactions subsequently reverse (Lehn and Zhao, 2006; Jaffe et al., 2013). Given the absence of arbitrage-induced short selling for cash-financed M&A deals, our main hypothesis is that bidders with higher anticipated merger arbitrage short selling include a larger proportion of cash in their payments.

We test this hypothesis using a sample of 798 M&A deals over the period 2002–2017 involving U.S.-domiciled, publicly-quoted bidders and targets. Consistent with recent empirical studies (Saffi and Sigurdsson, 2011; Massa et al., 2015; Prado et al., 2016; Chang et al., 2019; Dutordoir et al., 2019; Tsai et al., 2021), we base our main proxy for short-selling potential (*SSP*) on the supply of bidding firm shares that are available for lending. A higher lending supply indicates a higher ex ante potential for arbitrage-related short selling because investors face lower search costs of identifying shares to borrow (Duffie et al., 2002). In our M&A payment choice model, we control for a range of common payment choice determinants, including proxies for bidder information asymmetry, capital structure, and valuation (Martin, 1996; Faccio and Masulis, 2005; Chemmanur et al., 2009; Uysal, 2011; Boone et al., 2014; Karampatsas et al., 2014; Ben-David et al., 2015; Eckbo et al., 2018). In line with our main hypothesis, we find that *SSP* has a statistically and economically significant positive impact on the percentage of cash in M&A payments. A one standard deviation increase in *SSP* increases the percentage cash payment by 5.13%.

We run a series of tests to verify the robustness of this main result. We replace *SSP* with a measure of residual lending supply, constructed from a regression with bidder size, relative deal size, and bidder liquidity measures as independent variables, and find a positive impact of this *ResidualSSP* measure on the percentage of cash financing in M&A deals, consistent with the main result. We also re-estimate our baseline payment choice model with alternative proxies for short-selling potential from the literature (D'Avolio, 2002; Cohen et al., 2007; Saffi and Sigurdsson, 2011; Massa et al., 2015) and with an index comprising these different proxies. We consistently find that bidders with a higher short-selling potential are more likely to include a higher proportion of cash in their payments. In an instrumental variable analysis based on exchange-traded fund ownership, we control for the possible endogeneity of *SSP* and obtain similar results to those in the baseline payment choice model. We also analyze the effect of changes in *SSP* on changes in cash percentages in M&A deals for repeat bidders, again obtaining results consistent with those in the baseline analysis.

We execute additional tests to verify that the mitigation of arbitrage-related price pressure is the economic mechanism driving our main result. Because merger arbitrageurs cannot buy privately-held target shares, private target bids should not result in arbitrage-related short selling of bidder shares (Mitchell et al., 2004). Consistent with a merger arbitrage explanation of our main result, we indeed find that *SSP* has an insignificant impact on the proportion of cash in payments for public-to-private deals. A higher supply of lendable shares can influence payment choice through its association with bidder overvaluation (Ben-David et al., 2015) and bidder corporate governance (Chang et al., 2019). Reassuringly, we find that the positive effect of *SSP* on the cash share of M&A payment survives the inclusion of additional control variables suggested by these explanations. If bidder concerns about arbitrage-induced price pressure drive our main result, *SSP* should have a stronger impact on payment choice for deals with a higher likelihood of being completed, deals announced during periods with higher net flows into merger arbitrage funds, and bidders with a more inelastic demand for their stock. We find evidence consistent with each of these auxiliary hypotheses.

In a final set of additional tests, we directly examine price pressure following stock-financed M&A announcements. Measuring the expected price pressure attributable to merger arbitrage is empirically challenging because bidder stock price reactions to stock-financed deals also capture signaling effects (Mitchell et al., 2004). Our results on (expected) price pressure should be interpreted with this caveat in mind. We first document that higher *SSP* is effectively associated with stronger downward post-M&A announcement price pressure for stock-financed M&As, consistent with the key assumption behind our use of this proxy variable. We then derive pre-calibrated expected price pressure (*EPP*) proxies based on Chacko et al.'s (2008) price impact model. The proxies incorporate the bidder's lending supply, arbitrage demand, and the bidder's liquidity and volatility. The requirement for intraday trading data reduces the sample we can use for this analysis from 798 to 496 observations. We find that these *EPP* measures have a positive impact on the cash share in M&A payments, with an economic magnitude resembling that of the *SSP*-based result. Overall, the results of the additional tests corroborate that the mitigation of arbitrage-related price pressure is the economic channel driving our main result.

Our paper makes several contributions to the literature. Previous empirical studies of M&A payment choice include determinants suggested by rationales that focus on the role of capital structure, asymmetric information, overvaluation, contracting costs, and tax and accounting treatment (Hansen, 1987; Fishman, 1989; Eckbo et al., 1990; Shleifer and Vishny, 2003; Rhodes-Kropf and Viswanathan, 2004; Officer et al., 2009; de Bodt et al., 2018; Eckbo et al., 2018). We complement these studies by developing and testing a hypothesis on the role of merger arbitrageurs' anticipated trading strategies in determining M&A payments. Our results indirectly also add to the literature on M&A shareholder wealth effects, because a better understanding of payment choice determinants can lead to more accurate empirical specifications of tests of M&A stock price effects (Hansen, 1987; Faccio and Masulis, 2005).

In addition, our paper contributes to a young but rapidly growing literature on the interplay between corporate decisions and investor trades. Baker et al. (2007),

Chen et al. (2007), Bond et al. (2012), and Edmans et al. (2012) show how financial markets can affect corporate investment and takeover activity. More closely related to our study, several papers establish links between (anticipated) investor short selling and corporate finance and accounting decisions, including convertible bond design (de Jong et al., 2011), corporate investment (Grullon et al., 2015; Tsai et al., 2021), management forecasts (Li and Zhang, 2015), earnings management (Massa et al., 2015; Fang et al., 2016), executive incentive contracts (De Angelis et al., 2017), and the choice between shelf and traditional seasoned equity offerings (Dutordoir et al., 2019). Lamont (2012) discusses various actions that firms take to impede the short selling of their stock but excludes convertible and merger arbitrage short selling from his analysis. Chang et al. (2019) hypothesize and find that a higher short-selling threat reduces managers' incentives to engage in value-destroying M&As.

The paper continues as follows. In Section 2, we discuss relevant previous studies and develop our main hypothesis. In Section 3, we describe the sample and explanatory variables. We report the baseline results on the impact of *SSP* on M&A payment choice in Section 4. Section 5 provides tests verifying the robustness of our main result. In Section 6, we discuss tests examining the economic mechanism driving this result. We conclude in Section 7.

2. Relevant literature and main hypothesis

In this section, we position our paper within the literature on M&A payment choice and merger arbitrage and outline our main hypothesis.

2.1. M&A payment choice

In perfect capital markets, the medium of exchange or "payment choice" in M&A deals is irrelevant (Fishman, 1989). Various studies explore the market imperfections that can make the M&A payment choice relevant for firms. Because most cash bids require a form of debt financing, several authors predict and find that bidders with lower debt-related financing costs are more likely to use cash in their M&A payments (Martin, 1996; Bharadwaj and Shivdasani, 2003; Faccio and Masulis, 2005; Harford et al., 2009; Uysal, 2011; Karampatsas et al., 2014). Other studies examine the role of asymmetric information as a market imperfection affecting M&A payment choice (Hansen, 1987; Travlos, 1987; Fishman, 1989; Berkovitch and Narayanan, 1990; Eckbo et al., 1990; Eckbo et al., 2018). Shleifer and Vishny (2003) and Rhodes-Kropf and Viswanathan (2004) develop models of the role of bidder overvaluation in explaining payment choice. Dong et al. (2006), Ben-David et al. (2015) and Gao et al. (2021) obtain empirical evidence consistent with these overvaluation rationales. Other authors hypothesize and find that differences in the tax and accounting treatment of cash versus stock payments affect payment choice (Travlos, 1987; Heron and Lie, 2002; Boone et al., 2014). While these studies analyze firm- or deal-specific determinants, we focus on the role of anticipated merger arbitrage trading activities in determining M&A payment choice.

2.2. Merger arbitrage

When a merger is announced, target share prices typically do not increase by the full amount of the takeover premium due to the time value of money and the risk of deal failure (Weston et al., 2014). Merger arbitrageurs seek to capture the spread between the bidder's offer price and the target's stock price (Mitchell et al., 2007). The typical merger arbitrageur minimizes tracking error by investing in target shares when the merger is formally announced and liquidating upon completion of the deal (Mitchell et al., 2004). The strategy is not riskless, however, because the target stock price usually falls dramatically if the takeover bid fails (Mitchell and Pulvino, 2001).

Several studies focus on the risks and returns of merger arbitrage (Mitchell and Pulvino, 2001; Baker and Savaşoglu, 2002; Geczy et al., 2002). Geczy et al. (2002) find that, among various trading strategies that involve short selling, merger arbitrage is most strongly affected by short-selling constraints. Most relevant to our study, Mitchell et al. (2004) and Liu and Wu (2014) examine changes in short interest around critical dates in the M&A process associated with uninformed merger arbitrage trading activity. While these studies analyze the link between merger arbitrage and the shareholder wealth effects of M&As, we focus on how anticipated merger arbitrage trading activity affects M&A payment choice.

2.3. Main hypothesis

Firms differ in the ease with which merger arbitrageurs can short their stock (Geczy et al., 2002). Our main hypothesis is that bidders with a higher potential for merger arbitrage short selling are more likely to offer a larger proportion of cash in their M&A payments to avoid the negative price pressure associated with merger arbitrage activity.

This hypothesis hinges on the assumption that bidding firms want to mitigate the effects of arbitrage-driven price pressure on their stock, which may be the case for two reasons. First, several studies of price pressure from uninformed trading shocks generated by stock market index additions, convertible bond arbitrage, or convertible bond calls find that these shocks have a permanent component (Shleifer, 1986; Dhillon and Johnson, 1991; Mazzeo and Moore, 1992; Lynch and Mendenhall, 1997; Duca et al., 2012). Accordingly, bidding firms may try to avoid merger arbitrage short selling because they believe that part of its price pressure effect persists. Second, bidder announcement returns may act as a focal point for company stakeholders to judge the quality of a deal, the bidding firm, and its management. As a case in point, several studies use bidder announcement returns to proxy for the skill of a bidding firm or its management in conducting M&A deals (Lehn and Zhao, 2006; Jaffe et al., 2013; Golubov et al., 2015) without correcting for the effects of merger arbitrage. Further illustrating the importance given to bidder

announcement returns, business press and newswire articles announcing M&As routinely mention the bidder's stock price reaction to the deal announcement without referring to the component caused by merger arbitrage.[2] Given the adverse reputational effects of an immediate, negative stock price reaction associated with a M&A announcement, bidders may be keen to reduce the downward stock price impact of merger arbitrage short selling.

3. Sample and variables

In this section, we describe the construction of our sample of M&A deals. We also define our key *SSP* proxy and outline the control variables we use in the M&A payment choice model.

3.1. Sample construction

We obtain our sample from Thomson Securities Data Company (SDC) Platinum's Mergers & Acquisitions database. We focus on deals announced between June 2002 and December 2017. June 2002 is our starting month because equity lending data from Markit are available from May 2002. The sample includes completed and withdrawn deals. We use a set of standard screening criteria to clean the sample (Song and Walkling, 2000; Karampatsas et al., 2014; de Bodt et al., 2018). We require that bidders and targets are U.S.-domiciled, publicly-quoted firms and exclude financial and utility firms (SIC codes 6000−6999 and 4900−4999). We remove deals with a value below $1 million, acquisitions of partial interest, exchange offers, buybacks, recapitalizations, leveraged buyouts, repurchases, restructurings, spin-offs, self-tender offers, liquidations, divestitures, reverse takeovers, privatizations, bankruptcy acquisitions, and going private transactions. Because we focus on the choice between cash and stock as payment, we also eliminate a small number of deals mentioning other payment types, such as options or warrants in SDC Platinum's Consideration Structure data item. We further require the bidder to have stock return data available from the Center for Research in Security Prices (CRSP) database and accounting data for the fiscal year-end preceding the deal's announcement date (which we retrieve from SDC Platinum) available from Compustat. Finally, we require the bidder to have equity lending and value on loan data available from Markit. In Table 1, we outline the cleaning steps and the resulting number of observations after each step. We obtain a final sample of 798 M&A deals by 523 bidding firms. This sample size resembles those of other studies in the literature that focus on public-to-public M&A deals, accounting for different sample periods (Hackbarth and Morellec, 2008; Boone et al., 2014; de Bodt et al., 2018).

Table 2 reports the number of M&As by year for the sample and a breakdown by payment method. In line with Eckbo et al. (2018), we classify M&A deals into three categories: cash only (cash), a mixture of cash and stock (mixed), and stock only (stock). The number of M&A deals increases from 2003 until 2008. It remains steady from 2008 to 2010, with a sharp decline in 2011, reversing thereafter. The fraction of cash deals over the sample period (63.41%) is substantially higher than the fractions of mixed deals (20.18%) and stock deals (16.42%). These proportions resemble those in the literature for post-2000 M&A samples (Boone et al., 2014; Eckbo et al., 2018).

Table 1
Sample construction.
This table lists the steps we take to construct our sample and the resulting number of observations after each step. We obtain M&A deals from SDC Platinum.

Data screen	Number of deals
U.S. deals between public non-financial and non-utility firms announced between June 2002 and December 2017	8,388
Deal value greater than $1 million	7,774
Exclude acquisitions of partial interest, exchange offers, buybacks, recapitalizations, leveraged buyouts, repurchases, restructurings, spin-offs, self-tender offers, liquidations, divestitures, reverse takeovers, privatizations, bankruptcy acquisitions, and going private transactions	1,202
Consideration structure includes cash only, stock only, or cash and stock combinations, without other payment types, such as options and warrants	1,045
Bidders have relevant data available from CRSP and Compustat	871
Bidders have equity lending and on loan data available from Markit	798

3.2. The role of merger arbitrage in bidder announcement returns: replicating earlier studies

Before testing our main hypothesis, we verify that our sample bidders are not atypical in terms of the announcement period price pressure they experience. In a first step, we measure bidder stock price reactions around the M&A announcement date. Following a standard event study methodology (Brown and Warner, 1985), we define abnormal returns as the residuals from a one-factor market model estimated over a 200-day period ending 11 trading days before the M&A announcement date, with the CRSP value-weighted market index return proxying for the market return. We then calculate cumulative bidder abnormal stock returns ($CAR_{(-1,1)}$) over a three-day window centered around the deal's announcement date. Consistent with previous studies (Travlos, 1987; Bruner, 2004), we find positive stock price reactions around cash deal announcements (average $CAR_{(-1,1)}$ of 0.86%, $p < 0.001$) and negative stock price reactions around stock deal announcements (average $CAR_{(-1,1)}$ of −2.59%, $p < 0.05$).

In a second step, we estimate the portion of the negative bidder stock price reaction around stock deal announcements caused by price pressure from merger arbitrage short selling, using the two-stage regression approach of Mitchell et al. (2004) and Liu and Wu (2014). We find that arbitrage-driven short selling explains ap-

[2] Examples of Factiva articles mentioning stock price reactions to M&A announcements include: "Luminex buys Illinois biotech firm" (American City Business Journals, May 16 2016), and "Gilead to buy Kite for promising cancer therapies in $12 billion deal" (Reuters News, August 28 2017).

Table 2
M&A distribution by year.
This table gives the numbers of M&As by year for the full sample and for subsamples of deals by payment type. The sample period is from June 2002 to December 2017. We classify M&A deals into three categories based on the Consideration Structure data item from SDC Platinum: cash only deals (Cash), a mixture of cash and stock (Mixed), or stock only deals (Stock).

	Full sample	Cash		Mixed		Stock	
Year	Number (1)	Number	% of (1)	Number	% of (1)	Number	% of (1)
2002	17	11	64.71%	1	5.88%	5	29.41%
2003	65	32	49.23%	15	23.08%	18	27.69%
2004	64	36	56.25%	14	21.88%	14	21.88%
2005	75	39	52.00%	18	24.00%	18	24.00%
2006	71	51	71.83%	10	14.08%	10	14.08%
2007	68	50	73.53%	12	17.65%	6	8.82%
2008	55	38	69.09%	9	16.36%	8	14.55%
2009	54	30	55.56%	14	25.93%	10	18.52%
2010	56	42	75.00%	10	17.86%	4	7.14%
2011	29	19	65.52%	6	20.69%	4	13.79%
2012	43	29	67.44%	9	20.93%	5	11.63%
2013	38	28	73.68%	5	13.16%	5	13.16%
2014	38	25	65.79%	4	10.53%	9	23.68%
2015	52	27	51.92%	18	34.62%	7	13.46%
2016	42	29	69.05%	10	23.81%	3	7.14%
2017	31	20	64.52%	6	19.35%	5	16.13%
Total	798	506	63.41%	161	20.18%	131	16.42%

proximately 42% of the negative bidder stock price reaction around stock deal announcements, corresponding to an economically large market value decrease of $55.34 million for the median bidder.[3] This result resembles figures of 46% from Mitchell et al. (2004) and 62% from Liu and Wu (2014).

3.3. The SSP measure

To test our main hypothesis, we focus on a bidder's ex ante short-selling potential defined as "the maximum potential impact that short sellers may have on firm behavior or stock prices" (Massa et al., 2015). Consistent with recent empirical studies, we base our main proxy for short-selling potential, labelled *SSP*, on the total supply of bidder shares available to be lent for short sales (Saffi and Sigurdsson, 2011; Massa et al., 2015; Prado et al., 2016; Chang et al., 2019; Dutordoir et al., 2019; Tsai et al., 2021). Lending supply has the advantages that it is directly observable by managers and is clearly related to the theory of short-selling constraints (Massa et al., 2015; Tsai et al., 2021). A higher lending supply indicates lower short-selling constraints because investors face lower search costs when identifying shares to borrow (Duffie et al., 2002). These search costs can be substantial due to the opacity of the equity lending market in which transactions are only visible to the two parties involved (Kolasinski et al., 2013; Beneish et al., 2015). An implicit assumption in our use and interpretation of *SSP* is that a higher lending supply of bidder shares is associated with stronger downward arbitrage-induced bidder stock price pressure for stock-financed M&As.[4]

We obtain lending supply and value on loan data from Markit. The data are available at a monthly frequency from June 2002 to June 2004, at a weekly frequency from July 2004 to June 2006, and at a daily frequency thereafter, and we use them accordingly. To capture the net supply of shares that has not been committed to informed short sellers before the merger announcement (*LendingSupply*), we use the difference between the dollar value of the ex ante lending supply and the dollar value of bidder shares on loan as our main short-selling potential proxy. Consistent with prior studies, we scale *LendingSupply* by the firm's market capitalization on the corresponding day and define *SSP* as the average of this scaled measure over the three-month period ending one month before a deal's announcement.[5] In line with Saffi and Sigurdsson (2011), we find large variations in *SSP* across bidding firms. Approximately 24.2% of bidders have an *SSP* below 5%, while the maximum *SSP* percentage for our sample is 43.4%. In Panel A of Table 3, row 1 reports further descriptive statistics for *SSP* for the full sample and for subsamples grouped by payment type. Panel B gives the statistical significance of pairwise differences across the subsamples. Consistent with our main hypothesis, we find higher *SSP* values for cash M&As (average of 0.187) than for mixed (average of 0.141) and stock M&As (average of 0.103). The median values show a similar pattern. The differences in *SSP* values are significant at conventional levels across the three subsamples.

3.4. Control variables

In our baseline payment choice model, we control for a range of determinants suggested in the literature. We briefly motivate these. Firm characteristics refer to the bid-

[3] We do not tabulate the results of this analysis for space reasons. The results of this analysis and other unreported tests are available from the corresponding author upon request.

[4] In Section 6.4, we discuss tests to substantiate the relation between *SSP* and price pressure.

[5] In unreported tests, we obtain similar results when we use the lending supply unadjusted for the amount on loan.

Table 3
Descriptive statistics for variables in the M&A payment choice model.
This table reports means, medians, and standard deviations (SD) of explanatory variables in the M&A payment choice model (Panel A), differences in means (medians) of these variables between cash and mixed M&As, between cash and stock M&As, and between mixed and stock M&As (Panel B), and Pearson correlation coefficients between these variables (Panel C), with numbers referring to the corresponding variable name in Panel A. The Appendix gives the definitions of all variables. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Descriptive statistics for independent variables

	Full sample ($N = 798$)			Cash ($N = 506$)			Mixed ($N = 161$)			Stock ($N = 131$)		
	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD
(1) *SSP*	0.164	0.186	0.114	0.187	0.205	0.103	0.141	0.130	0.121	0.103	0.061	0.116
(2) Ln*Assets*	7.838	7.747	2.014	8.357	8.191	1.850	7.373	7.355	1.887	6.405	6.420	1.951
(3) *Leverage*	0.187	0.156	0.190	0.176	0.152	0.180	0.240	0.210	0.222	0.164	0.123	0.176
(4) *CashReserves*	0.217	0.161	0.195	0.207	0.157	0.177	0.204	0.143	0.190	0.273	0.207	0.248
(5) *EarningsVol*	0.080	0.023	0.478	0.043	0.018	0.106	0.097	0.035	0.195	0.205	0.057	1.135
(6) *MTB*	3.399	2.565	7.962	3.167	2.701	7.815	3.746	2.221	6.220	3.866	2.231	10.155
(7) *Runup*	0.035	0.020	0.170	0.011	0.007	0.122	0.072	0.059	0.195	0.082	0.039	0.259
(8) *RelSize*	0.381	0.149	0.901	0.256	0.074	1.015	0.640	0.482	0.606	0.549	0.353	0.586
(9) *Hostile*	0.060	0.000	0.238	0.067	0.000	0.251	0.081	0.000	0.273	0.008	0.000	0.087
(10) *Tender*	0.239	0.000	0.427	0.330	0.000	0.471	0.118	0.000	0.324	0.038	0.000	0.192
(11) *PrivateCompetitor*	0.041	0.000	0.199	0.047	0.000	0.213	0.043	0.000	0.205	0.015	0.000	0.123
(12) *OverlapBidder*	0.411	0.333	0.324	0.364	0.333	0.306	0.478	0.500	0.338	0.508	0.444	0.341
(13) *OverlapTarget*	0.524	0.500	0.356	0.506	0.500	0.363	0.544	0.500	0.344	0.566	0.500	0.338

Panel B: Differences in means and medians of independent variables across subsamples based on M&A payment type

	Cash vs. Mixed differences		Cash vs. Stock differences		Mixed vs. Stock differences	
	Mean	Median	Mean	Median	Mean	Median
(1) *SSP*	0.046***	0.075***	0.084***	0.144***	0.038***	0.069***
(2) Ln*Assets*	0.984***	0.836***	1.952***	1.771***	0.968***	0.935***
(3) *Leverage*	−0.064***	−0.058***	0.012	0.029	0.076***	0.087***
(4) *CashReserves*	0.003	0.014	−0.066***	−0.050**	−0.069***	−0.064**
(5) *EarningsVol*	−0.054***	−0.017***	−0.162***	−0.039***	−0.108	−0.022**
(6) *MTB*	−0.579	0.480*	−0.699	0.470***	−0.120	−0.010
(7) *Runup*	−0.061***	−0.052***	−0.071***	−0.032**	−0.010	0.020
(8) *RelSize*	−0.384***	−0.408***	−0.293***	−0.279***	0.091	0.129*
(9) *Hostile*	−0.014	0.000	0.059***	0.000***	0.073***	0.000***
(10) *Tender*	0.212***	0.000***	0.292***	0.000***	0.080**	0.000**
(11) *PrivateCompetitor*	0.004	0.000	0.032*	0.000*	0.028	0.000
(12) *OverlapBidder*	−0.114***	−0.167***	−0.144***	−0.111***	−0.030	0.056
(13) *OverlapTarget*	−0.038	0.000	−0.060*	0.000*	−0.022	0.000

Panel C: Pairwise correlations between independent variables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(2)	0.320***											
(3)	−0.056	0.155***										
(4)	−0.116***	−0.319***	−0.358***									
(5)	−0.125***	−0.191***	−0.060*	0.145***								
(6)	0.022	−0.001	0.038	0.058	0.025							
(7)	−0.129***	−0.145***	0.076**	0.052	0.017	0.062*						
(8)	−0.076**	−0.183***	0.362***	−0.072**	0.037	−0.018	0.091***					
(9)	0.038	−0.017	0.085**	−0.022	−0.021	−0.026	0.018	0.103***				
(10)	0.100***	0.121***	−0.137***	0.054	−0.021	0.022	−0.046	−0.122***	0.006			
(11)	−0.016	−0.011	0.069**	−0.011	0.009	−0.102***	−0.010	0.094***	0.186***	0.090**		
(12)	−0.014	−0.198***	0.078**	0.121***	0.081**	−0.011	0.017	0.120***	0.056	−0.063*	0.085**	
(13)	−0.057	0.014	0.081**	0.094***	0.028	0.009	−0.038	0.070**	−0.025	−0.032	0.004	0.555***

ding firm. The predicted sign of the variable refers to its impact on bidding firms' likelihood of including (more) cash as part of their payment. We measure firm characteristics at the fiscal year-end preceding the M&A deal's announcement unless noted otherwise. In the Appendix, we provide detailed definitions of all the variables and their sources.

Firms with more assets (Ln*Assets*) tend to have a lower default probability and should therefore be more likely to include cash as part of their M&A payment, given that cash payments typically require a form of debt financing (Faccio and Masulis, 2005; Karampatsas et al., 2014). Firms with a higher debt ratio (*Leverage*) may have higher costs of raising additional debt, for example because of the potential agency costs of underinvestment (Myers, 1977; Faccio and Masulis, 2005), but also a higher debt capacity because firms with more debt outstanding have proven their ability to borrow (Lemmon and Zender, 2010). The predicted impact of *Leverage* is therefore unclear. Firms with greater cash reserves (*CashReserves*) are more likely to use cash to finance their investment projects (Myers, 1984; Jensen, 1986; Martin, 1996; Pinkowitz et al., 2013), so we predict this variable will have a positive impact. Firms with a higher earnings volatility (*EarningsVol*) may find it

more difficult to borrow, either because of a debt overhang problem (Myers, 1977) or because they are less likely to be able to fulfill their debt obligations (Lemmon and Zender, 2010), resulting in a negative predicted impact. A higher market-to-book (*MTB*) ratio could be associated with higher information asymmetry about the bidder (Boone et al., 2014), yielding a positive predicted impact. But *MTB* could also be associated with profitable growth opportunities, making bidder shares an attractive investment for target shareholders (Martin, 1996; Faccio and Masulis, 2005). Finally, *MTB* could proxy for bidder overvaluation (Rhodes-Kropf et al., 2005; Dong et al., 2006; Eckbo et al., 2018). Together, the two latter arguments yield a predicted negative impact of *MTB*. The overall predicted impact of *MTB* is thus ambiguous. Like *MTB*, a higher pre-announcement stock run-up (*Runup*) can proxy for information asymmetry, growth opportunities, and overvaluation, so its predicted impact is unclear (Faccio and Masulis, 2005; Boone et al., 2014).

We next control for a range of deal-specific characteristics. To the extent that the ratio of the deal size to bidder size (*RelSize*) captures higher merger arbitrage-related short selling, it should be associated with a higher cash percentage in M&A payments, consistent with our main hypothesis (Mitchell et al., 2004). However, *RelSize* can also capture a range of other payment drivers, including agency problems, overvaluation, availability of growth opportunities, cash constraints, and information available about a firm (Hansen, 1987; Mitchell et al., 2004; Harford et al., 2009; Alexandridis et al., 2013; Schneider and Spalt, 2021). Collectively, these explanations do not yield a clear prediction for the impact of *RelSize*. In hostile M&A deals, bidders may want to offer cash to consummate the deal more quickly and deter competition (Fishman, 1989; Berkovitch and Narayanan, 1990). We thus predict a positive impact of a *Hostile* dummy variable. Because tender offers paid with stock might cause unwelcome delays due to additional regulatory requirements, we also expect a *Tender* dummy variable to have a positive impact (Karampatsas et al., 2014). Competition from private bidders may increase pressure on public bidders to pay with cash because the former have no other payment option due to the illiquidity of their stock (Eckbo et al., 2018). We thus expect a *PrivateCompetitor* dummy variable to have a positive impact. In industries in which target firms are well acquainted with the bidder's business sector, targets should be less reluctant to accept stock as payment due to a lower risk of overpayment (Faccio and Masulis, 2005). We therefore expect *OverlapBidder* and *OverlapTarget*, two measures of bidder and target activity relatedness suggested by Eckbo et al. (2018), to have a negative impact.

Panel A in Table 3 reports the summary statistics of the control variables for the full sample and subsamples split by M&A payment method. Panel B reports the mean and median values of the independent variables for pairs of subsamples. We find significant differences in several of the control variables across the three subsamples. As expected, bidder size (Ln*Assets*) is larger for deals with a larger portion of cash. *RelSize*, for which we have no clear expectation, is higher for mixed and stock M&As than for cash M&As. Regarding other deal-specific characteristics, the percentages of *Hostile, Tender*, and *PrivateCompetitor* deals are higher in cash deals than in stock deals, whereas the degree of industry relatedness (*OverlapBidder*) is lower, all consistent with expectations. Panel C reports the Pearson correlations between the explanatory variables, which suggest that multicollinearity is not a problem for our analysis.

4. The impact of short-selling potential on M&A payments: baseline tests

To test the impact of *SSP* on M&A payments, we use a two-boundary Tobit regression as our baseline model following Faccio and Masulis (2005). The dependent variable is the percentage of cash in the M&A payment (*CashPercentage*). The regressions include year dummies to control for intertemporal fluctuations in a bidder's propensity to pay with cash.

Column 1 in Table 4 reports the coefficients from the baseline model. We report *t*-statistics based on heteroscedasticity-consistent standard errors, but our results are robust to using industry- or firm-level clustered standard errors. Consistent with our prediction, *CashPercentage* is positively related to *SSP*. In terms of economic significance (not tabulated), a one standard deviation increase in *SSP* increases *CashPercentage* by 5.13% and increases (decreases) the probability of a cash- (stock-)only deal by 5.90% (4.05%).[6] We find that Ln*Assets, Hostile*, and *Tender* have a positive impact, while *Runup* and *OverlapBidder* have a negative impact, in line with our predictions for these control variables.

The remaining columns of Table 4 provide the results of initial sensitivity tests of our baseline model. We re-estimate the model using an ordinary least squares (OLS) linear probability regression. While an OLS model may be less efficient for analyzing censored dependent variables, we adopt this specification in subsequent M&A payment choice regressions that include interaction terms because the interpretation of interaction terms is more straightforward in a linear specification than in Tobit regressions (Ai and Norton, 2003; Greene, 2010; de Bodt et al., 2018). Angrist and Pischke (2009) defend the use of OLS with limited dependent variables more generally. In column 2, we find that the OLS results resemble the average marginal effects we obtain for the Tobit regression. Most importantly, the coefficient on *SSP* is positive, as predicted. A one standard deviation increase in *SSP* increases *CashPercentage* by 6.65%.

Following Eckbo et al. (2018), we also employ a multinomial probit model to analyze bidding firms' likelihood of using cash and mixed M&A deals, each compared with the base outcome of stock deals. This model abstracts from the exact percentage of cash included in the M&A payment. In column 3, we find that bidders with higher *SSP* are more likely to use cash M&A deals than stock M&A deals, while in column 4 we find that *SSP* has an insignificant impact

[6] As deHaan (2021) recommends, we base the reporting of all economic significance results in the paper on within-fixed effect standard deviations. In our empirical design, this means using within-year standard deviations.

Table 4
Baseline M&A payment choice model.
The table reports coefficients from a Tobit regression (column 1), OLS regressions (columns 2 and 5) and a multinomial probit regression (columns 3 and 4). In columns 1, 2, and 5, the dependent variable is the percentage of cash in the M&A payment (*CashPercentage*). In columns 3 and 4, the outcomes are cash only deals, mixed payment deals, and stock only deals (the base outcome). In columns 1 to 4, we examine the full sample of M&A deals. In column 5, we examine mixed payment deals only. The Appendix gives the definitions of all variables. We include the predicted signs of explanatory variables as (+) or (−) signs next to their name, with (+/−) indicating an ambiguous prediction. *t*-statistics reported in parentheses are based on heteroscedasticity-consistent standard errors. *, **, and *** indicate significance at 10%, 5%, and 1%, respectively.

	Full sample				Mixed deals only
	Tobit	OLS	Multinomial probit		OLS
			Cash vs. Stock	Mixed vs. Stock	
	1	2	3	4	5
SSP (+)	2.259***	0.707***	3.229***	0.829	0.602**
	(3.82)	(4.61)	(3.22)	(0.78)	(2.41)
Bidding firm characteristics:					
Ln*Assets* (+)	0.186***	0.047***	0.337***	0.161***	0.013
	(5.33)	(6.24)	(5.66)	(2.67)	(0.93)
Leverage (+/−)	−0.262	−0.105	0.635	0.989*	−0.303***
	(−0.87)	(−1.20)	(1.15)	(1.74)	(−2.98)
CashReserves (+)	0.382	0.051	0.570	−0.140	−0.135
	(1.23)	(0.62)	(1.19)	(−0.28)	(−1.27)
EarningsVol (−)	−0.315	−0.028**	−1.115*	−0.037	0.022
	(−0.97)	(−2.36)	(−1.95)	(−0.40)	(0.21)
MTB (+/−)	−0.007	−0.003**	−0.011	−0.001	0.003
	(−1.21)	(−2.03)	(−1.10)	(−0.06)	(1.20)
Runup (+/−)	−0.683**	−0.228***	−1.287**	0.011	−0.022
	(−2.15)	(−2.96)	(−2.49)	(0.02)	(−0.19)
Deal characteristics:					
RelSize (−)	−0.101	−0.023	−0.136	−0.011	0.007
	(−0.79)	(−0.56)	(−0.96)	(−0.16)	(0.32)
Hostile (+)	0.561**	0.146***	1.401**	1.462**	−0.038
	(2.45)	(2.85)	(2.34)	(2.48)	(−0.48)
Tender (+)	0.878***	0.208***	1.917***	0.865***	0.057
	(5.98)	(8.04)	(6.31)	(2.69)	(0.80)
External pressure to pay in cash:					
PrivateCompetitor (+)	0.358	0.124***	0.541	0.309	0.211**
	(1.63)	(2.58)	(0.89)	(0.51)	(2.45)
Information asymmetry:					
OverlapBidder (−)	−0.666***	−0.174***	−0.923***	−0.132	−0.032
	(−3.29)	(−3.31)	(−2.75)	(−0.40)	(−0.38)
OverlapTarget (−)	0.096	0.014	−0.017	−0.196	−0.085
	(0.55)	(0.33)	(−0.06)	(−0.63)	(−1.09)
Year fixed effects	Yes	Yes	Yes		Yes
(Pseudo) R^2	0.167	0.301			0.315
Log likelihood			−570.193		
N	798	798	798		161

on the choice between mixed and stock M&A deals. A binary distinction between mixed and stock deals may be too blunt to capture payment choices. To verify whether *SSP* affects the cash percentage within mixed deals, we re-estimate the baseline model for column 2 excluding cash- and stock-only deals. The results in column 5 show that *SSP* has a significant positive impact on the cash share of mixed deals, consistent with our main hypothesis.

As Table IA1 in the Internet Appendix shows, our baseline results remain unaltered when we add further control variables suggested by the literature that are unavailable for the entire sample (Hansen, 1987; Eckbo et al., 1990, 2018; Houston and Ryngaert, 1997; Officer, 2004; Chemmanur et al., 2009; Harford et al., 2009; Uysal, 2011; Karampatsas et al., 2014). In particular, we obtain highly similar coefficients and significance of *SSP* when we add controls for bidders' credit ratings and deviations from bidders' target cash and leverage ratios, as well as more sophisticated bidder information asymmetry proxies. Our results also remain unchanged when we add target characteristics and further measures of information asymmetry between bidder and target.

5. The impact of short-selling potential on M&A payments: robustness tests

In this section, we examine the sensitivity of our main result to alternative measures of short-selling potential and endogeneity biases.

5.1. Alternative short-selling potential measures

As Table 3, Panel C documents, *SSP* is positively correlated with bidder size (Ln*Assets*) and negatively correlated with relative deal size (*RelSize*). A higher bidder size and lower relative deal size may be associated with lower short selling price pressure (Mitchell et al., 2004). To address concerns that *SSP*'s positive impact on the percentage cash

Table 5
Robustness to using alternative short-selling potential proxies.
The table reports Tobit regression results using different short-selling potential proxies and a composite short-selling determinants index (*SSDI*). The dependent variable is the percentage of cash in the M&A payment (*CashPercentage*). In column 1, the standard errors are corrected for the fact that *ResidualSSP* is a generated regressor using a bootstrapping procedure including both the first- and second-step regressions with 200 replications. The Appendix gives the definitions of all variables. We include the predicted signs of short-selling determinants as (+) or (−) signs next to their name, with (+/−) indicating an ambiguous prediction. *t*-statistics reported in parentheses are based on heteroscedasticity-consistent standard errors. *, **, and *** indicate significance at 10%, 5%, and 1%, respectively.

	1	2	3	4	5
ResidualSSP (+)	0.139***				
	(3.76)				
MinusFee (+)		0.138***			
		(3.31)			
Option (+)			0.222*		
			(1.84)		
InstitOwnership (+)				0.643***	
				(3.21)	
SSDI (+)					0.308***
					(4.94)
Other controls:					
Bidding firm characteristics	Yes	Yes	Yes	Yes	Yes
Deal characteristics	Yes	Yes	Yes	Yes	Yes
External pressure to pay in cash	Yes	Yes	Yes	Yes	Yes
Information asymmetry	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.171	0.168	0.172	0.187	0.203
N	798	802	868	805	740

financing is driven by its proxying for observable characteristics that are negatively associated with price pressure, we replace it with a *ResidualSSP* measure. We construct this measure with a two-stage approach that Nagel (2005) and Chang et al. (2019) also use in the context of lending supply measures. In a first stage, we regress a logit transformation of *SSP* on bidder size, relative size, and liquidity proxies, consistent with Chang et al. (2019). In line with Nagel (2005), we allow for a non-linear impact of bidder size by including its squared value. Table IA2 in the Internet Appendix presents the regression results, which indicate that *SSP* is positively associated with bidding firm size and liquidity, consistent with the findings from the pairwise correlation analysis. In a second stage, we include the residuals from this regression (*ResidualSSP*) in the baseline M&A payment model in column 1 of Table 4, instead of *SSP*. We adjust the standard errors of the independent variables for the fact that *ResidualSSP* is a generated regressor using a bootstrapping procedure including both the first- and second-step regressions with 200 replications (Chen et al., 2020). Column 1 in Table 5 presents the results. Reassuringly, we find *ResidualSSP* has a positive impact. A one standard deviation increase in *ResidualSSP* increases the percentage cash payment by 5.55%.

For completeness, we also analyze the sensitivity of our main result from column 1 of Table 4 to using alternative measures of short-selling potential from the literature. First, we consider a proxy inversely related to loan fees (*MinusFee*). A high loan fee reflects a high cost of borrowing, limiting the attractiveness of short selling (Saffi and Sigurdsson, 2011; Prado et al., 2016). We multiply loan fees by minus one for consistency with other proxies that capture short-selling potential rather than constraints and rank the resulting variable into quintiles. We measure this proxy as an average over the three-month period preceding the M&A deal's announcement month. Our second proxy captures investors' desire to short sell the bidder's stock, measured as a dummy variable equal to one for bidding firms with put options outstanding (*Option*). Because investors who cannot short sell the stock directly can purchase put options (Figlewski and Webb, 1993; Danielson and Sorescu, 2001; Graham and Hughen, 2007), we expect *Option* to have a positive association with a bidder's short-selling potential. Our third alternative proxy is institutional ownership (*InstitOwnership*). Higher institutional ownership typically indicates that more shares are available for short sellers to borrow (Asquith et al., 2005; Nagel, 2005; de Jong et al., 2011; Prado, 2015). Because short-selling potential is hard to capture with a single proxy, we also construct a short-selling determinants index (*SSDI*) by categorizing bidding firms each year into quintiles based on *SSP, MinusFee, Option*, and *InstitOwnership*. Consistent with Dutordoir et al. (2019), we assign a ranking value of one to five to each quintile, with bidders in the quintile with the highest short-selling propensity receiving a value of five and so on down to bidders in the quintile with the lowest propensity receiving a value of one. We assign the components equal weights and compute the index for each bidder in an M&A deal announcement year by taking the average ranking value based on the four measures. Of the 798 deals in our baseline sample, 58 have missing values for *InstitOwnership,* leaving us with 740 deals that have sufficient information to construct *SSDI*. We report descriptive statistics of alternative short-selling potential proxies and pairwise correlation coefficients between the individual proxies in Table IA3 in the Internet Appendix.

Columns 2–5 of Table 5 report the coefficients from Tobit payment choice regressions using these alternative short-selling potential proxies instead of *SSP*. As predicted, we find that *MinusFee, Option, InstitOwnership,* and *SSDI* have a positive impact on the percentage cash payment. A one standard deviation increase in *MinusFee* (*Option, Insti-*

Table 6
Instrumental variable regressions.
The table reports coefficients from two-stage least squares (2SLS) regressions using the percentage of the bidder's stock held by ETFs (*ETF*) as an instrument for *SSP*. We regress *SSP* on *ETF* in the first stage and regress the percentage of cash in the M&A payment (*CashPercentage*) on the predicted *SSP* estimated from the first-stage regression in the second stage, with control variables and year fixed effects. The Appendix gives the definitions of all variables. We include the predicted signs of explanatory variables as (+) or (−) signs next to their name, with (+/−) indicating an ambiguous prediction. *t*-statistics reported in parentheses are based on heteroscedasticity-consistent standard errors. *, **, and *** indicate significance at 10%, 5%, and 1%, respectively.

	SSP 1st stage	*CashPercentage* 2nd stage
Instrumented SSP (+)		0.939**
		(2.02)
ETF (+)	1.408***	
	(6.10)	
Other controls:		
Bidding firm characteristics	Yes	Yes
Deal characteristics	Yes	Yes
External pressure to pay in cash	Yes	Yes
Information asymmetry	Yes	Yes
Year fixed effects	Yes	Yes
R^2	0.451	0.294
N	683	683

tOwnership, SSDI) increases *CashPercentage* by 4.34% (2.28%, 5.06%, 3.95%). We conclude that our main finding is robust to using alternative proxies for a bidder's short-selling potential.

5.2. Instrumental variable analysis

If institutional investors have information on potential bidding firms and their possible payment choices, they may adjust their supply of lendable shares in response. We address this potential reverse causality with a two-stage least squares (2SLS) regression using exchange-traded fund (ETF) ownership as an instrument to identify exogenous variation in *SSP*, as suggested by Massa et al. (2015). ETFs typically generate additional income by lending shares to short sellers, suggesting a positive relation between ETF ownership and *SSP*, thereby satisfying the relevance requirement of instrumental variables. In addition, because the primary goal of ETFs is to minimize tracking error relative to benchmarks rather than to actively control firms, it is unlikely that changes in their holdings have a significant effect on a bidding firm's payment choice, satisfying the exclusion condition. We measure ETF ownership (*ETF*) as the fraction of the bidder's stock held by ETFs that replicate indices. The data are from CRSP's mutual funds database. After matching with this database, our sample falls to 683 M&A deals.

Table 6 reports the coefficients from the 2SLS regression. In the first-stage regression, *SSP* is strongly positively related to *ETF*, in line with our prediction. In the second-stage regression estimated with OLS (Wooldridge, 2010), the coefficient on the instrumented *SSP* is positive, inconsistent with a reverse causality interpretation for our main result.

Table 7
Analysis of repeat bidders.
This table reports coefficients from a Tobit regression limited to bidders that announce more than one M&A over the sample period. The dependent variable is the change in the percentage of cash payment between the current deal and the bidder's previous deal (Δ*CashPercentage*). The independent variable of interest is the change in *SSP* relative to its value at the time of the bidder's previous deal (Δ*SSP*). Other continuous independent variables are also measured as changes from their values at the time of the previous deal. The Appendix gives definitions of all the variables. We include the predicted signs of explanatory variables as (+) or (−) signs next to their name, with (+/−) indicating an ambiguous prediction. *t*-statistics reported in parentheses are based on heteroscedasticity-consistent standard errors. *, **, and *** indicate significance at 10%, 5%, and 1%, respectively.

Δ*SSP* (+)	5.214**
	(2.06)
Other controls:	
Bidding firm characteristics	Yes
Deal characteristics	Yes
External pressure to pay in cash	Yes
Information asymmetry	Yes
Year fixed effects	Yes
Pseudo R^2	0.278
N	239

5.3. Analysis of repeat bidders

Limiting the payment choice analysis to bidders that announce multiple deals over the sample period allows us to further mitigate the concern that unobservable firm characteristics drive our findings. Building on our main hypothesis, we expect that bidders with a positive change in *SSP* since their previous bid are more likely to increase the percentage cash payment in their subsequent bid. There are 123 repeat bidders involved in 362 deals in our sample. We estimate the baseline model in Table 4, column 1 for these bidders. The dependent variable in this analysis is the change in the percentage of cash in the M&A payment (Δ*CashPercentage*) relative to its value at the time of the bidder's previous M&A deal. The main independent variable is the change in *SSP* relative to its value at the time of the bidder's previous deal (Δ*SSP*). We also measure all other continuous independent variables as changes from their values at the time of the previous deal. Table 7 reports the results. As predicted, we find that Δ*SSP* has a positive impact on Δ*CashPercentage*.

6. The impact of short-selling potential on M&A payments: the economic mechanism

Having verified the robustness of our main result, we next conduct additional tests examining the economic mechanism driving this finding.

6.1. Privately-held targets

A corollary of our main hypothesis is that a bidder's short-selling potential should not impact the cash percentage in payments for privately-held targets because arbitrageurs cannot set up positions in these targets (Mitchell et al., 2004). Analyzing privately-held

Table 8
M&A payment choice model including privately-held targets.
The table reports results from a Tobit regression (column 1) analyzing the sample of M&As involving private targets and an OLS regression (column 2) analyzing the sample of M&As involving public and private targets. The dependent variable is the percentage of cash in the M&A payment (*Cash-Percentage*). The Appendix gives definitions of all the variables. We include the predicted signs of explanatory variables as (+) or (−) signs next to their name, with (+/−) indicating an ambiguous prediction. *t*-statistics reported in parentheses are based on heteroscedasticity-consistent standard errors. *, **, and *** indicate significance at 10%, 5%, and 1%, respectively.

	1	2
SSP (+)	0.197	0.877***
	(1.21)	(5.77)
Private (+)		0.160***
		(2.96)
SSP× *Private* (−)		−0.836***
		(−5.52)
Other controls:		
Bidding firm characteristics	Yes	Yes
Deal characteristics	Yes	Yes
External pressure to pay in cash	Yes	Yes
Information asymmetry	Yes	Yes
Year fixed effects	Yes	Yes
(Pseudo) R^2	0.148	0.227
N	2,800	3,598

targets thus provides a placebo test of our baseline analysis. We collect a raw sample of public-to-private M&As from SDC using analogous screening criteria to those outlined in Section 3.1, yielding 19,244 deals. After executing the various cleaning steps listed in Table 1, we obtain a sample of 2,800 public-to-private deals. We then re-run our baseline model (Table 4, column 1) on this sample. Table 8 reports the coefficients. As predicted, we find that *SSP* has an insignificant impact on the percentage cash payment in M&A deals involving privately-held targets.

Next, we combine our baseline sample of publicly-quoted targets with our sample of privately-held targets and add an *SSP* × *Private* interaction between *SSP* and a *Private* dummy variable that equals one if the target is privately held. The regression results in column 2 show that the main effect of *Private* is positive, consistent with findings of de Bodt et al. (2018). Most importantly, as predicted, we find a negative coefficient for the interaction term, reducing the positive impact of *SSP* on *CashPercentage* to an insignificant 0.041 (0.877 − 0.836, $F = 0.71$) when the target is a private firm.

6.2. Bidder overvaluation and corporate governance as alternative explanations

In addition to proxying for arbitrage-induced short-selling potential, a higher supply of shares available for lending could capture lower constraints on informed short selling, thus acting as an inverse proxy for the bidder's level of overvaluation. This alternative interpretation is consistent with lending supply having a positive impact on the cash share of M&A payments. We note, however, that our *SSP* measure captures the net supply of bidder shares after deducting the value of shares on loan to short sellers, reducing its likelihood of acting as an inverse proxy for overvaluation.

To formally investigate whether overvaluation drives our main result, we repeat the baseline payment choice analysis in Table 4, column 1 including more sophisticated overvaluation measures. We replace *MTB* with a measure of overvaluation resembling those in Rhodes-Kropf et al. (2005), Fu et al. (2013), and Golubov et al. (2016). This *Overvaluation* proxy captures the difference between a firm's equity market value and its fundamental equity value, calculated as the predicted value from cross-sectional regressions of market value on firm characteristics for each industry and year. We further augment the model with the *ShortInterestRank* misvaluation measure of Ben-David et al. (2015). We measure *ShortInterestRank* as the quintile ranking of an M&A deal based on the bidder's stock split-adjusted short interest six months before the deal announcement. A higher ranking corresponds to a higher adjusted short interest ratio, implying a more positive misvaluation. Column 1 of Table 9 reports the results of this analysis. Importantly, *SSP* has a positive impact on *CashPercentage*, suggesting that its impact on payment choice is not caused by it acting as an inverse proxy for bidder overvaluation. Consistent with Ben-David et al. (2015), bidders in the highest two quintile rankings are less likely to choose cash payments than bidders in the lowest quintile ranking.

A second alternative explanation for our findings relates to the possible disciplining role of short selling. Chang et al. (2019) predict that firms with higher short-selling potential are less likely to engage in value-destroying M&A deals because short sellers tend to quickly trade on a negative deal assessment, depressing stock prices. Consistent with this prediction, they document that a variable resembling our *SSP* measure has a positive influence on bidder announcement returns. Applying this argument to the relation between *SSP* and M&A payment, a higher *SSP* might discipline firms to choose a higher cash percentage in their M&A payment that is likely debt financed. If this is the case, however, we should find that *SSP* has a positive effect on the percentage cash payment for privately-held targets (Table 8), which we do not.

To further examine whether the disciplining role of short selling drives our main result, we augment our baseline M&A payment model with two standard corporate governance proxies, namely the number of directors on the board (*BoardSize*) and the ratio of independent directors to total directors on the board (*BoardIndependence*). A smaller board size is more effective at monitoring managerial effort and actions (Yermack, 1996), while more independent boards should result in higher monitoring quality (Weisbach, 1988; Byrd and Hickman, 1992). If *SSP* mainly captures the monitoring effect that these two variables measure more directly, we expect its significance to decline after including these corporate governance proxies. Column 2 of Table 9, however, shows that *SSP*'s impact remains similar in magnitude to that in the baseline regression in Table 4, column 1.

Table 9
Analysis of overvaluation and corporate governance as alternative explanations.
The table reports coefficients from Tobit regressions accounting for additional overvaluation (column 1) and corporate governance (column 2) proxies. The dependent variable is the percentage of cash in the M&A payment (*CashPercentage*). In the regression for column 1, we introduce a measure of bidding firm overvaluation (*Overvaluation*) that is similar to Rhodes-Kropf et al. (2005) and add quintile indicators of bidders' pre-announcement short interest that proxy for misvaluation, in line with Ben-David et al. (2015). In the regression for column 2, we add the number of directors on the board (*BoardSize*) and the ratio of independent to total directors on the board (*BoardIndependence*) as proxies for bidding firm corporate governance. The Appendix gives the definitions of all the variables. We include the predicted signs of explanatory variables as (+) or (−) signs next to their name, with (+/−) indicating an ambiguous prediction. *t*-statistics reported in parentheses are based on heteroscedasticity-consistent standard errors. *, **, and *** indicate significance at 10%, 5%, and 1%, respectively.

	1	2
SSP (+)	2.419***	2.284***
	(4.00)	(3.31)
Overvaluation (−)	−0.021	
	(−0.22)	
ShortInterestRank2 (−)	−0.164	
	(−0.98)	
ShortInterestRank3 (−)	−0.173	
	(−0.99)	
ShortInterestRank4 (−)	−0.341*	
	(−1.91)	
ShortInterestRank5 (−)	−0.444***	
	(−2.58)	
BoardSize (−)		−0.044
		(1.26)
BoardIndependence (+)*BoardIndependence* (+)		0.759
		(1.51)
Other controls:		
Bidding firm characteristics	Yes	Yes
Deal characteristics	Yes	Yes
External pressure to pay in cash	Yes	Yes
Information asymmetry	Yes	Yes
Year fixed effects	Yes	Yes
Pseudo R^2	0.191	0.185
N	742	571

6.3. Moderators of the relation between SSP and M&A payment choice

Our main hypothesis yields auxiliary predictions on potential determinants that may affect the strength of the positive impact of short-selling potential on a bidder's likelihood to pay with cash. Examining these moderators enables us to further verify the economic mechanism driving *SSP*'s impact on the cash share in M&A payments.

A deal with a higher completion likelihood may be more attractive to merger arbitrageurs because they receive the increase in the target's stock price upon removal of market uncertainty about the deal (Mitchell et al., 2004; Weston et al., 2014). We therefore predict that *SSP* will have a more positive impact on deals with a higher completion probability. We estimate this probability (*PrCompleted*) from a probit regression modeling the determinants of M&A deal outcomes. The dependent variable in this regression, *Completed*, equals one if SDC Platinum lists the deal's status as completed (563 deals) and zero if it lists the status as withdrawn (83 deals). We derive the independent variables and their rationales from Baker and Savaşoglu (2002) and Betton et al. (2014). The predicted impact of a variable denotes its influence on the likelihood of deal completion. We expect *Hostile* to have a negative impact because the negotiation process for hostile deals might be less straightforward than for friendly deals. We expect *Tender* to have a positive impact because successful tender offers tend to provide positive abnormal returns to target shareholders. We also expect a positive impact for a *Toehold* dummy variable equal to one if the bidder already owns target shares at the merger announcement. We predict a negative impact for target size (*TFirmLnAssets*) for reasons associated with the ease of obtaining the required financing for a deal. In addition, we expect proxies capturing the similarity between bidder and target business activities (*OverlapBidder* and *OverlapTarget*) to have a negative impact because horizontal deals may face stronger regulatory hurdles. Finally, we predict that a takeover premium (*Premium*) has a positive impact because deals with a higher premium are more likely to receive target shareholder approval. Table IA4 in the Internet Appendix reports the first-stage probit regression results. As predicted, the probability of deal completion is positively related to *Tender* and negatively related to *Hostile* and *OverlapBidder*. Column 1 in Table 10 reports the results of the baseline OLS M&A payment model in Table 4, column 2 augmented with an interaction of *SSP* with *PrCompleted* (*SSP* × *PrCompleted*). We correct standard errors for the fact that *PrCompleted* is generated from a first-stage regression using a bootstrapping procedure including both the first- and second-step regressions with 200 replications. As predicted, we find a positive coefficient on the interaction term.

M&A deals announced in periods in which there is a higher supply of capital for merger arbitrage are more likely to be targeted for short selling by merger arbitrageurs. We therefore expect *SSP* to have a stronger positive impact on deals announced in periods with

Table 10
Analysis of potential moderators.
This table reports coefficients from OLS regressions with interactions of *SSP* with proxies for deal completion risk (column 1), merger arbitrage fund flows (column 2), inelasticity (column 3), and collar and floating exchange ratio deals (column 4). The dependent variable is the percentage of cash in the M&A payment (*CashPercentage*). The Appendix gives definitions of all the variables. We include the predicted signs of interaction terms as (+) or (−) signs next to their name. *t*-statistics reported in parentheses are based on heteroscedasticity-consistent standard errors. We correct the standard errors in column 1 for the fact that *PrCompleted* is a generated regressor using a bootstrapping procedure including both the first- and second-step regressions with 200 replications. *, **, and *** indicate significance at 10%, 5%, and 1%, respectively.

	1	2	3	4
SSP (+)	−0.839	0.571***	−0.344	0.448**
	(−1.29)	(3.49)	(−0.91)	(2.44)
PrCompleted	−0.492			
	(−0.52)			
SSP × *PrCompleted* (+)	1.573**			
	(2.18)			
MAFundFlow		−1.268**		
		(−2.15)		
SSP × *MAFundFlow* (+)		7.070***		
		(2.87)		
InelasticityIndex			−0.111***	
			(−4.66)	
SSP × *InelasticityIndex* (+)			0.316**	
			(2.41)	
CollarFloating				0.159***
				(3.29)
SSP × *CollarFloating* (−)				−0.046
				(−0.15)
Other controls:				
Bidding firm characteristics	Yes	Yes	Yes	Yes
Deal characteristics	Yes	Yes	Yes	Yes
External pressure to pay in cash	Yes	Yes	Yes	Yes
Information asymmetry	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
R^2	0.343	0.308	0.359	0.297
N	646	798	740	292

more flows into merger arbitrage funds. In line with Choi et al. (2010) and Duca et al. (2012), we measure merger arbitrage fund flows (*MAFundFlow*) as the percentage change in flows into merger arbitrage funds (adjusted for fund returns) over the quarter before the merger announcement month. Funds flow data are from the Eureka-Hedge database (Joenväärä et al., 2021). We select funds that state "arbitrage" as their main investment strategy and "M&A" as their secondary strategy or give "merger arbitrage" as their secondary strategy (no funds give merger arbitrage as their main strategy). We identify 104 such funds over our sample period. The annual average (median) over our sample period of the aggregate assets under management of these funds is $60.50 ($40.05) billion. Column 2 reports the results of the baseline OLS payment choice regression including an interaction of *SSP* with *MAFundFlow* (*SSP* × *MAFundFlow*). Consistent with our prediction, this interaction term has a positive coefficient.

Bidders with a more inelastic demand for their stocks should exhibit a stronger negative response to uninformed supply shocks that are associated with arbitrage short selling. Thus, a more inelastic demand might result in a stronger incentive to prevent arbitrage-induced short sales using cash payments. Since the inelasticity of a stock's demand curve is hard to capture with a single proxy, we construct an index (*InelasticityIndex*) measured as the average quintile ranking of an M&A deal based on three inelasticity proxies suggested by Wurgler and Zhuravskaya (2002) and Gao and Ritter (2010): (inverse) average daily order flow, risk arbitrage, and non-institutional ownership in the bidding firm. Column 3 reports the results of the baseline OLS regression that includes an interaction of *SSP* with this index (*SSP* × *InelasticityIndex*). Consistent with our prediction, the interaction term has a positive coefficient.

Until now, we have not distinguished different stock financing types, which include fixed exchange ratio, floating exchange ratio, and collar deals (Mitchell et al., 2004). Unlike fixed exchange ratio deals, for which the exchange ratio between bidder and target shares is set at the announcement, floating exchange ratio deals announce the value rather than the number of shares to be exchanged. Because the number of shares is only determined after a pricing period, which typically starts several weeks after the bid announcement, there should be no arbitrage-driven short selling between the announcement and the end of the pricing period of the latter deals (Mitchell et al., 2004). Collar deals are a hybrid between fixed exchange ratio and floating exchange ratio deals, with either the number or the value of bidder stock to be exchanged set within a range, depending on the bidder's stock price. As the bidder's stock price changes, arbitrageurs need to continuously adjust their short positions to remain hedged (Officer, 2004). Consistent with Liu and Wu (2014), we find that most stock and mixed M&A deals in our sample are fixed exchange ratio deals; only 34 of these deals (11.64%) have floating exchange ratios and 31 of these deals (10.62%) have collar payment arrangements. If bidding firms want to avoid highly negative announcement period stock price reactions to M&A deals by adjusting the cash percentage of their payment, they should be less con-

cerned about price pressure at the end of a pricing period. In such a scenario, we should observe that *SSP*'s impact is weaker for floating exchange ratio and collar deals than for fixed exchange ratio deals. On the other hand, if bidding firms are mostly concerned about a permanent effect of supply shocks due to long-term price-inelasticity, there should be no difference in the effect of *SSP* between these stock-financed deal types. Column 4 reports the results of the baseline OLS regression that includes an interaction of *SSP* with a dummy variable for floating exchange ratio and collar deals (*SSP* × *CollarFloating*). We exclude cash-financed deals from this analysis. We find an insignificant coefficient on the interaction term, suggesting that bidders may be concerned about the long-term price pressure effects that are associated with inelasticity of the demand for stock, rather than merely the announcement period effects. We caution, however, that this analysis is based on a very small number of floating exchange ratio and collar deals.

6.4. Impact of expected price pressure on M&A payment choice

A key assumption underpinning our baseline tests is that a higher net lending supply, as captured by our *SSP* proxy, is associated with stronger downward price pressure following stock-financed M&A announcements. In this subsection, we first verify this assumption. We then provide more direct evidence on the payment choice impact of expected price pressure (*EPP*) proxies incorporating bidders' net lending supply.

Accurately measuring price pressure is difficult even in a setting without confounding information effects, due to the innate noisiness of daily stock returns around large corporate events (Chacko et al., 2008). In our setting, these challenges are compounded by the fact that abnormal stock returns around stock-financed M&A announcements capture both signaling and price pressure effects (Mitchell et al., 2004). In addition, *SSP* represents the ex ante maximum short selling threat, rather than the actual trading positions of merger arbitrageurs (Massa et al., 2015). Bearing these caveats in mind, we map *SSP* into the price pressure around M&A announcements. Liu and Wu (2014) find evidence suggesting that merger arbitrage-induced trading activity happens during the three-week period following a merger announcement. We therefore measure cumulative abnormal stock returns (*CAR*) from the merger announcement date to three weeks after the announcement date. Column 1 in Panel A of Table 11 reports the results of this price impact analysis. We find that *SSP* has a negative impact on *CAR*. In column 2, we repeat this analysis adding relevant control variables to the regression in column 1. We expect a higher stock return volatility (*Volatility*), a lower liquidity (proxied by higher *Amihud* and lower *TradingVolume*), and a larger relative deal size (*RelSize*) to be associated with more negative price pressure effects (Mitchell et al., 2004; Chacko et al., 2008). We again find a negative coefficient on *SSP*. Therefore, reassuringly, the results in Panel A corroborate our assumption that higher *SSP* translates into more negative post-announcement stock price returns for stock-financed M&As.

Table 11
Analysis of expected price pressure measures and their impact on M&A payment choice.
Panel A reports coefficients from OLS regressions of cumulative abnormal returns (*CARs*) over the three-week period after M&A announcements using the sample of stock deals. In column 1, we report results of a regression examining the impact of *SSP* on *CAR*. In column 2, we re-run the regression in column 1 adding relevant control variables. Columns 3 and 4 present price impact functions of *CAR* on two *EPP* measures derived from Chacko et al., (2008). Panel B re-runs the baseline payment choice model in Table 4, column 1 replacing *SSP* with *OrderFlow*(*Q*) (column 1) and E[*p*(*Q*)] (column 2), respectively. The Appendix gives definitions of all the variables. We include the predicted signs of explanatory variables as (+) or (−) signs next to their name, with (+/−) indicating an ambiguous prediction. *t*-statistics reported in parentheses are based on heteroscedasticity-consistent standard errors. *, **, and *** indicate significance at 10%, 5%, and 1%, respectively.

Panel A: Price impact regressions	1	2	3	4
SSP (−)	−0.209*	−0.233*		
	(−1.81)	(−1.72)		
Volatility (−)		−0.033		
		(−0.50)		
Amihud (−)		0.000		
		(0.16)		
TradingVolume (+)		0.002		
		(0.24)		
RelSize (−)		−0.030		
		(−1.03)		
OrderFlow(*Q*) (−)			−0.0001***	
			(−2.91)	
E[*p*(*Q*)] (−)				−0.887***
				(−4.62)
Intercept	0.005	0.000	−0.004	−0.002
	(0.08)	(0.00)	(−0.02)	(−0.09)
Year fixed effects	Yes	Yes	No	No
R^2	0.087	0.104	0.093	0.132
N	131	131	73	73

Panel B: Payment choice regressions	1	2
OrderFlow(*Q*) (+)	0.001***	
	(2.82)	
E[*p*(*Q*)] (+)		3.500**
		(2.04)
Other controls:		
Bidding firm characteristics	Yes	Yes
Deal characteristics	Yes	Yes
External pressure to pay in cash	Yes	Yes
Information asymmetry	Yes	Yes
Year fixed effects	Yes	Yes
Pseudo R^2	0.260	0.272
N	496	496

We next develop pre-calibrated *EPP* measures based on Chacko et al.'s (2008) price impact model. The measures, which rely on intraday trading data, allow us to examine the impact of anticipated price pressure on M&A payment choice, while avoiding the noise associated with directly using post-announcement *CAR*. The trade-off is a reduction in sample size, from 798 to 496 M&A deals with sufficient transaction-level data on Thomson Reuters Tick History (TRTH). We label the *EPP* measures *OrderFlow*(*Q*) and E[*p*(*Q*)], consistent with Chacko et al.'s terminology. *Order-*

Flow(*Q*) is defined as:

$$\text{OrderFlow(Q)} = \sqrt{\text{Q}/\lambda}, \quad (1)$$

where *Q* is the dollar value of the expected quantity shorted in a fully stock-financed M&A deal. Like other studies, we do not have exact information on the trading positions of merger arbitrageurs (Cornelli and Li, 2002). To capture arbitrage demand, we pragmatically assume that arbitrageurs buy the entire target, consistent with Mitchell et al. (2004). As demonstrated in their Eq. (2), the dollar value to be shorted in this scenario (approximately) equals the M&A transaction value. To reflect supply constraints, we define the amount *Q* as the smaller of this M&A transaction value and *LendingSupply*.[7] The sell order arrival rate λ captures liquidity and is based on one month of intraday sell order quantities for bidding firm stock measured in the calendar month preceding the M&A announcement month. In the Appendix, we provide more details of the calculation of realized transaction costs, which follows Lee and Ready (1991).

E[*p*(*Q*)] is defined as:

$$\text{E}[p(\text{Q})] = \hat{\beta}_0 + \sigma\sqrt{\text{Q}/2\lambda}. \quad (2)$$

E[*p*(*Q*)] differs from *OrderFlow*(*Q*) by adopting an appropriate scaling and including a volatility adjustment, as well as an intercept that captures the potential fixed costs associated with liquidity shocks. In theory, E[*p*(*Q*)] should have a coefficient of −1 in the price impact function (Chacko et al., 2008). Both *EPP* measures are significantly positively correlated with *SSP* (0.083, $p < 0.05$ for *OrderFlow*(*Q*) and 0.08, $p < 0.10$ for E[*p*(*Q*)]). In columns 3 and 4 of Panel A of Table 11, we provide price impact functions of *CAR* following stock-financed M&A announcements regressed on these *EPP* measures. We omit year dummies from these regressions as our sample size is small (73 stock deals with intraday trading data availability). We also exclude other control variables because the two measures already embed liquidity (*OrderFlow*(*Q*)) and liquidity and volatility (*E*[*p*(*Q*)]). Both measures have a negative price impact, as predicted. The coefficient on E[*p*(*Q*)] of −0.887 is reasonably close to its theoretical value considering the unavoidable noise inherent in *CAR*. The *F*-statistic for the difference between −1 and this coefficient is 0.35.

Having established that *OrderFlow*(*Q*) and E[*p*(*Q*)] are indeed associated with the amount of negative price pressure around M&A announcements, with a coefficient size on E[*p*(*Q*)] close to its theoretical value, we next substitute these measures for *SSP* in the baseline M&A payment model of Table 4, column 1. As predicted, both pre-calibrated price pressure proxies have positive coefficients in columns 1 and 2 in Panel B of Table 11. A one standard deviation increase in *OrderFlow*(*Q*) (E[*p*(*Q*)]) increases the *CashPercentage* in M&A deals by 4.11% (1.95%).[8]

[7] Of the 496 deals available for this analysis, 205 (41.33%) have an M&A transaction value that is higher than *LendingSupply*. For the total sample of 798 deals, this percentage is similar (51.25%).

[8] When we re-estimate the baseline payment choice analysis from column 1 in Table 4 on the same 496 observations in the *EPP* analysis, we find that a one standard deviation increase in *SSP* increases *CashPercentage* by 2.83%. The pseudo R^2 of this reduced-sample *SSP*-based analysis is 0.214, also closely resembling that of the *EPP*-based Tobit regressions in Table 11, Panel B.

7. Conclusion

We hypothesize that bidders with higher short-selling potential are more likely to include a higher proportion of cash in their M&A payments to avoid negative price pressure resulting from merger arbitrage short sales. Our baseline sample consists of 798 public-to-public M&A deals announced between mid-2002 and 2017, involving U.S.-domiciled firms.

Consistent with our prediction, we find that the ex ante net lending supply of bidder shares has a positive impact on the percentage of cash included in M&A payments, controlling for a wide range of other payment determinants suggested by the literature. We document the robustness of our main result by conducting a range of further tests, including an instrumental variables analysis.

We execute additional tests to verify the economic mechanism driving our results. A placebo analysis of privately-held targets, tests aimed at examining the role of bidder overvaluation and corporate governance, a moderator analysis examining the role of deal completion, merger arbitrage fund inflows and inelasticity of the demand for stock, and an analysis of the impact of expected price pressure proxies derived from Chacko et al. (2008), all corroborate our interpretation that bidders adjust the cash percentage in their payment to mitigate arbitrage-induced short selling price pressure.

Overall, our results suggest that the potential for arbitrage-driven short selling has a first-order effect on M&A payment choice. As such, our paper adds to a growing literature analyzing the interplay between corporate finance decisions and (anticipated) investor short-selling trades.

Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Supplementary materials

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Appendix

Variable definitions and sources.

Variable	Definition	Data source(s)
Amihud	Ratio of absolute stock return to its dollar trading volume averaged over 200 trading days ending 11 days before the announcement (multiplied by 10^6).	CRSP
BoardIndependence	Ratio of independent to total directors on the board for the bidder in the latest year before the M&A deal announcement.	BoardEx
BoardSize	Number of directors on the board for the bidder in the latest year before the M&A deal announcement.	BoardEx
CAR	Cumulative abnormal stock return over the three-week period after M&A announcements. Abnormal returns are the residuals from the one-factor market model. We estimate the model over a 200-day period ending 11 days before the announcement date and use the CRSP value-weighted return for the market return.	CRSP
CashPercentage	The percentage of cash in the M&A payment.	SDC
CashReserves	Ratio of cash and short-term investments to total assets for the bidder. Cash and short-term investment and total assets are financial year-end figures for the year ending before the M&A deal announcement.	Compustat
CollarFloating	Dummy variable equal to one if the deal is a collar or floating exchange ratio stock deal.	SDC
Completed	Dummy variable equal to one if the deal's status is completed.	SDC
EarningsVol	Standard deviation of income before extraordinary items relative to the bidder's total assets over the prior three years ending before the M&A deal announcement. Income before extraordinary items and total assets are financial year-end figures.	Compustat
$E[p(Q)]$	Expected price impact, calculated as $E[p(Q)] = \hat{\beta}_0 + \sigma\sqrt{Q/2\lambda}$. Q is the smaller of the M&A transaction value and *LendingSupply*. σ is the per second volatility, measured as the standard deviation of daily returns over the month ending one month before the M&A announcement date. The sell order arrival rate (λ) is calculated through the equation: $\lambda = \sigma^2/2\hat{\beta}_1^2$. The intercept ($\hat{\beta}_0$) and coefficient ($\hat{\beta}_1$) are estimated from a weighted least square regression: $\overline{p(SQ)} = \beta_0 + \beta_1 \times \sqrt{\overline{SQ}}$. $p(SQ)$ is the percentage transaction costs, measured as the difference in trade price relative to the price of the previous trade scaled by the previous trade price for each transaction. SQ is the dollar value for the transaction quantity. We keep all seller-initiated transactions for each bidding firm stock over one month ending one month before the M&A announcement date and require each unique transaction quantity bucket to contain at least 20 observations. Within each sell quantity bucket, we calculate the average transaction costs ($\overline{p(SQ)}$) and the average dollar transaction value ($\overline{SQ}$) using the transaction quantity multiplied by the median stock price over the period. We then estimate the regression with weights equal to the total value of transactions within each quantity bucket.	CRSP, Markit, Thomson Reuters Tick History
ETF	Average ETF ownership for the bidder in the three months ending one month before the M&A deal announcement. ETF ownership is the number of shares held by ETFs that replicate indices divided by shares outstanding on the report date.	CRSP Mutual Funds
Hostile	Dummy variable equal to one for deals defined as "hostile" or "unsolicited."	SDC
Variable	Definition	Data source(s)
InelasticityIndex	Inelasticity index, measured as the average quintile ranking of an M&A deal based on three individual inelasticity proxies: the average daily order flow, a risk arbitrage measure, and non-institutional ownership. Average daily order flow is the natural logarithm of the average daily absolute value of the raw stock return divided by turnover over the 200 trading days ending 11 days before the M&A announcement. The risk arbitrage measure is the natural logarithm of the variance of market model OLS regression residuals over the 200 trading days ending 11 days before the M&A deal announcement. Non-institutional ownership is measured as (1−*InstitOwnership*).	CSRP, Thomson Reuters Institutional (13f) Holdings
InstitOwnership	Number of shares in the bidder held by institutions divided by shares outstanding at the end of the latest quarter before the M&A deal announcement date.	Thomson Reuters Institutional (13f) Holdings
Leverage	Ratio of long-term debt to total assets for the bidder. Long-term debt and total assets are financial year-end figures for the year ending before the M&A deal announcement.	Compustat
Ln*Assets*	Natural logarithm of the bidder's total assets. Total assets are financial year-end figures for the year ending before the M&A deal announcement.	Compustat
Ln*Assets*Sqr	The square of Ln*Assets*.	Compustat

(*continued on next page*)

(*continued*)

Variable	Definition	Data source(s)
MAFundFlow	Percentage change in flows into merger arbitrage funds over the quarter before the M&A deal announcement month, measured as the aggregate change in assets under management over the quarter across funds (adjusted for the returns of each fund) scaled by the aggregate lagged assets for each quarter across funds.	EurekaHedge
MinusFee	Quintile ranking of a deal based on the indicative fee $\times -1$. Indicative fee is the expected borrowing cost for a hedge fund on a given day, in fee terms, measured as the average fee in the three months ending one month before the M&A deal announcement.	Markit
MTB	Ratio of the market value to the book value of equity for the bidder. Market and book values of equity are financial year-end figures for the latest year before the M&A deal announcement.	Compustat
Option	Dummy variable equal to one if the bidder's stock has put options outstanding in the three months ending one month before the M&A deal announcement.	Option Metrics
OrderFlow(*Q*)	Square root of the ratio of *Q* to sell order arrival rate (λ). *Q* is the smaller of the M&A transaction value and *LendingSupply*. The sell order arrival rate (λ) is calculated as outlined in the description of $E[p(Q)]$.	CRSP, Markit, Thomson Reuters Tick History
OverlapBidder	Number of overlapping 4-digit SIC codes between the bidder and target divided by the number of bidder 4-digit SIC codes.	SDC
OverlapTarget	Number of overlapping 4-digit SIC codes between the bidder and target divided by the number of target 4-digit SIC codes.	SDC
Overvaluation	The difference between the bidder's market value and fundamental value. Fundamental value is the predicted value from the OLS regression: Ln*Market value* $= \beta_0 + \beta_1$*LnBook value* $+ \beta_2$*LnPositive component of net income* $+ \beta_3$*LnNegative component of net income* $+ \beta_4$*Leverage* $+ e$. The βs are estimated based on all Compustat firms in the firm's Fama–French 12 industry in year *t*. Market value, book value, and net income are financial year-end figures. Positive and negative components are binary indicators for net income being positive or negative.	Compustat
Variable	Definition	Data source(s)
PrCompleted	The predicted value from a probit model regression of the determinants of the merger outcome, based on Baker and Savaşoglu (2002) and Betton et al. (2014). The dependent variable equals one if the deal's status is completed. The independent variables include *Hostile, Tender, Toehold, TFirm*Ln*Assets, OverlapBidder, OverlapTarget*, and *Premium*.	Compustat, CRSP, SDC
Premium	Takeover premium equal to the difference between the target share price 20 days before the deal announcement and the offer price scaled by the target share price two days after the announcement.	CRSP, SDC
Private	Dummy variable equal to one if the target is privately held.	SDC
PrivateCompetitor	Dummy variable equal to one if there are private bidders competing for the same target.	SDC
ResidualSSP	The residual from an OLS regression of *LogitSSP on* Ln*Assets,* Ln*Assets*Sqr, *RelSize, Amihud*, and *TradingVolume. LogitSSP* is the logit transformation of *SSP* following Nagel (2005), measured as the logarithm of the ratio of *SSP* to one minus *SSP*. We replace values of *SSP* below 0.0001 with 0.0001.	CRSP, Markit
RelSize	Ratio of the deal value to the market value of the bidding firm. Market values are financial year-end figures for the year ending before the M&A deal announcement.	Compustat, SDC
Runup	The bidder's buy-and-hold abnormal return over the 60 trading days ending 2 days before the announcement net of the CRSP value-weighted market return.	CRSP
ShortInterestRank	The quintile ranking of an M&A deal based on split-adjusted short interest, proxying for misvaluation. Numbers 2 to 5 indicate dummies for the second through fifth quintiles of the adjusted short interest distribution. Adjusted short interest is the difference between the short interest ratio of the bidding firm and the average short interest ratio of other firms in the Compustat Supplemental Short Interest File database six months before the M&A announcement. Short interest ratio is the number of shares sold short scaled by the total shares outstanding in month *t*.	Compustat Supplemental Short Interest File, CRSP
SSDI	Short-selling determinants index, measured as the average quintile ranking of an M&A deal based on individual short-selling potential proxies (*SSP, MinusFee, Option*, and *InstitOwnership*).	CRSP, Markit, Option Metrics, Thomson Reuters Institutional (13f) Holdings
SSP	Average difference between the lending supply and the loan quantity for the bidder in the three months ending one month before the M&A deal announcement date. Lending supply (loan quantity) is the dollar value of shares available for lending (on loan) on a given day scaled by the bidder's market capitalization on that day.	CSRP, Markit
Tender	Dummy variable equal to one for tender offers.	SDC
*TFirm*Ln*Assets*	Natural logarithm of the target's total assets.	Compustat
Toehold	Dummy variable equal to one if the bidder owns shares in the target at the M&A announcement.	SDC
TradingVolume	Average dollar trading volume over 200 trading days ending 11 days before the M&A announcement.	CRSP
Volatility	Annualized stock return volatility, calculated from daily stock returns over the 200 trading days ending 11 days before the M&A announcement.	CRSP

References

Ai, C., Norton, E., 2003. Interaction terms in logit and probit models. Econ. Lett. 80, 123–129.

Alexandridis, G., Fuller, K., Terhaar, L., Travlos, N., 2013. Deal size, acquisition premia and shareholder gains. J. Corp. Finance 20, 1–13.

Amihud, Y., Lev, B., Travlos, N., 1990. Corporate control and the choice of investment financing: the case of corporate acquisitions. J. Finance 45, 603–616.

Angrist, J., Pischke, J-S., 2009. Mostly Harmless Econometrics. Princeton University Press.

Asquith, P., Pathak, P., Ritter, J., 2005. Short interest, institutional ownership, and stock returns. J. Financ. Econ. 78, 243–276.

Baker, M., Savaşoglu, S., 2002. Limited arbitrage in mergers and acquisitions. J. Financ. Econ. 64, 91–115.

Baker, M., Coval, J., Stein, J., 2007. Corporate financing decisions when investors take the path of least resistance. J. Financ. Econ. 84, 266–298.

Ben-David, I., Drake, M., Roulstone, D., 2015. Acquirer valuation and acquisition decisions: identifying mispricing using short interest. J. Financ. Quant. Anal.J. Financ. Quant. Anal. 50, 1–32.

Beneish, M., Lee, C., Nichols, D., 2015. In short supply: short-sellers and stock returns. J. Account. Econ. 60, 33–57.

Berkovitch, E., Narayanan, M., 1990. Competition and the medium of exchange in takeovers. Rev. Financ. Stud. 3, 153–174.

Betton, S., Eckbo, B., Thompson, R., Thorburn, K., 2014. Merger negotiations with stock market feedback. J. Finance 69, 1705–1745.

Bharadwaj, A., Shivdasani, A., 2003. Valuation effects of bank financing in acquisitions. J. Financ. Econ. 67, 113–148.

Bond, P., Edmans, A., Goldstein, I., 2012. The real effects of financial markets. Ann. Rev. Financ. Econ. 4, 339–360.

Boone, A., Lie, E., Liu, Y., 2014. Time trends and determinants of the method of payment in M&As. J. Corp. Finance 27, 296–304.

Brown, S., Warner, J., 1985. Using daily stock returns: the case of event studies. J. Financ. Econ. 14, 3–31.

Bruner, R., 2004. Applied Mergers and Acquisitions. John Wiley & Sons, Hoboken, New Jersey.

Byrd, J., Hickman, K., 1992. Do outside directors monitor managers? Evidence from tender offer bids. J. Financ. Econ. 32, 195–221.

Chacko, G., Jurek, J., Stafford, E., 2008. The price of immediacy. J. Finance 63, 1253–1290.

Chang, E., Lin, T., Ma, X., 2019. Does short-selling threat discipline managers in mergers and acquisitions decisions? J. Account. Econ. 68, 1–18.

Chemmanur, T., Paeglis, I., Simonyan, K., 2009. The medium of exchange in acquisitions: does the private information of both acquirer and target matter? J. Corp. Finance 15, 523–542.

Chen, Q., Goldstein, I., Jiang, W., 2007. Price informativeness and investment sensitivity to stock price. Rev. Financ. Stud. 20, 619–650.

Chen, W., Hribar, P., Melessa, S., 2020. Incorrect inferences when using generated regressors in accounting research. Unpublished working paper. Available at SSRN.

Choi, D., Getmansky, M., Henderson, B., Tookes, H., 2010. Convertible bond arbitrageurs as suppliers of capital. Rev. Financial Studies 23, 2492–2522.

Cohen, L., Diether, K., Malloy, C., 2007. Supply and demand shifts in the shorting market. J. Finance 62, 2061–2096.

Cornelli, F., Li, D., 2002. Risk arbitrage in takeovers. Rev. Financ. Stud. 15, 837–868.

Danielson, B., Sorescu, S., 2001. Why do option introductions depress stock prices? a study of diminishing short-sale constraints. J. Financ. Quant. Anal. 36, 451–484.

D'Avolio, G., 2002. The market for borrowing stock. J. Financ. Econ. 66, 271–306.

De Angelis, D., Grullon, G., Michenaud, S., 2017. The effects of short-selling threats on incentive contracts: evidence form an experiment. Rev. Financ. Stud. 30, 1627–1659.

De Bodt, E., Cousin, J., Roll, R., 2018. Full-stock-payment marginalization in merger and acquisition transactions. Manage Sci. 64, 760–783.

DeHaan, E., 2021. Using and interpreting fixed effects models. Unpublished working paper. Available at SSRN.

De Jong, A., Dutordoir, M., Verwijmeren, P., 2011. Why do convertible issuers simultaneously repurchase stock? An arbitrage-based explanation. J financ econ 100, 113–129.

Dhillon, U., Johnson, H., 1991. Changes in the standard and poor's 500 List. J. Bus. 64, 75–85.

Dong, M., Hirshleifer, D., Richardson, S., Teoh, S., 2006. Does investor misevaluation drive the takeover market? J. Finance 61, 725–762.

Duca, E., Dutordoir, M., Veld, C., Verwijmeren, P., 2012. Why are convertible bond announcements associated with increasingly negative issuer stock returns? an arbitrage-based explanation. J. Bank. Finance 36, 2884–2899.

Duffie, D., Garleanu, N., Pedersen, L., 2002. Securities lending, shorting, and pricing. J. Financ. Econ. 66, 307–339.

Dutordoir, M., Strong, N., Sun, P., 2019. Shelf versus traditional seasoned equity offerings: the impact of potential short selling. J. Financ. Quant. Anal. 54, 1285–1311.

Eckbo, B., Giammarino, R., Heinkel, R., 1990. Asymmetric information and the medium of exchange in takeovers: theory and tests. Rev. Financ. Stud. 3, 651–675.

Eckbo, B., Makaew, T., Thorburn, K., 2018. Are stock-financed takeovers opportunistic? J. Financ. Econ. 128, 443–465.

Edmans, A., Goldstein, I., Jiang, W., 2012. The real effects of financial markets: the impact of prices on takeovers. J. Finance 67, 933–971.

Faccio, M., Masulis, R., 2005. The choice of payment method in European mergers and acquisitions. J. Finance 60, 1345–1388.

Fang, V., Huang, A., Karpoff, J., 2016. Short selling and earnings management: a controlled experiment. J. Finance 71, 1251–1294.

Figlewski, S., Webb, G., 1993. Option, short sales, and market completeness. J. Finance 48, 761–777.

Fishman, M., 1989. Preemptive bidding and the role of the medium of exchange in acquisitions. J. Finance 44, 41–57.

Fu, F., Lin, L., Officer, M., 2013. Acquisitions driven by stock overvaluation: are they good deals? J. Financ. Econ. 109, 24–39.

Fuller, K., Netter, J., Stegemoller, M., 2002. What do returns to acquiring firms tell us? evidence from firms that make many acquisitions. J. Finance 57, 1763–1793.

Gao, N., Kolokolova, O., Mattes, A., 2021. Do hedge funds shape merger payment? Unpublished working paper. Available at SSRN.

Gao, X., Ritter, J., 2010. The marketing of seasoned equity offerings. J. Financ. Econ. 97, 33–52.

Geczy, C., Musto, D., Reed, A., 2002. Stocks are special too: an analysis of the equity lending market. J. Financ. Econ. 66, 241–269.

Golubov, A., Yawson, A., Zhang, H., 2015. Extraordinary acquirers. J. Financ. Econ. 116, 314–330.

Golubov, A., Petmezas, D., Travlos, N., 2016. Do stock-financed acquisitions destroy value? new methods and evidence. Rev. Financ. 20, 161–200.

Graham, J., Hughen, J., 2007. Ownership structure, expectations, and short sales on the Nasdaq. J. Econ. Finance 31, 33–48.

Greene, W., 2010. Testing hypotheses about interaction terms in nonlinear models. Econ. Lett. 107, 291–296.

Grullon, G., Michenaud, S., Weston, J., 2015. The real effects of short--selling constraints. Rev. Financ. Stud. 28, 1737–1767.

Hackbarth, D., Morellec, E., 2008. Stock returns in mergers and acquisitions. J. Finance 63, 1213–1252.

Hansen, R., 1987. A theory for the choice of exchange medium in mergers and acquisitions. J. Bus. 60, 75–95.

Harford, J., Klasa, S., Walcott, N., 2009. Do firms have leverage targets? evidence from acquisitions. J. Financ. Econ. 93, 1–14.

Heron, R., Lie, E., 2002. Operating performance and the method of payment in takeovers. J. Financ. Quant. Anal. 37, 137–155.

Houston, J., Ryngaert, M., 1997. Equity issuance and adverse selection: a direct test using conditional stock offers. J. Finance 52, 197–219.

Jaffe, J., Pedersen, D., Voetmann, T., 2013. Skill differences in corporate acquisitions. J. Corp. Finance 23, 166–181.

Jensen, M., 1986. Agency costs of free cash flow, corporate finance, and takeovers. Am. Econ. Rev. 76, 323–329.

Joenväärä, J., Kauppila, M., Kosowski, R., Tolonen, P., 2021. Hedge fund performance: are stylized facts sensitive to which database one uses? Crit. Finance Rev. 10, 271–327.

Karampatsas, N., Petmezas, D., Travlos, N., 2014. Credit ratings and the choice of payment method in mergers and acquisitions. J. Corp. Finance 25, 474–493.

Kolasinski, A., Reed, A., Ringgenberg, M., 2013. A multiple lender approach to understanding supply and search in the equity lending market. J. Finance 68, 559–595.

Lamont, O., 2012. Go down fighting: short sellers vs. firms. Rev. Asset Pricing Studies 2, 1–30.

Lee, C., Ready, M., 1991. Inferring trade direction from intraday data. J. Finance 46, 733–746.

Lehn, K., Zhao, M., 2006. CEO turnover after acquisitions: are bad bidders fired? J. Finance 61, 1759–1811.

Lemmon, M., Zender, J., 2010. Debt capacity and tests of capital structure theories. J. Financ. Quant. Anal. 45, 1161–1187.

Li, Y., Zhang, L., 2015. Short selling pressure, stock price behavior, and management forecast precision: evidence from a natural experiment. J. Account. Res. 53, 79–117.

Liu, T., Wu, J., 2014. Merger arbitrage short selling and price pressure. J. Corp. Finance 27, 36–54.
Lynch, A., Mendenhall, R., 1997. New evidence on stock price effects associated with changes in the S&P 500 index. J. Bus. 70, 351–383.
Martin, K., 1996. The method of payment in corporate acquisitions, investment opportunities, and management ownership. J. Finance 51, 1227–1246.
Massa, M., Zhang, B., Zhang, H., 2015. The invisible hand of short selling: does short selling discipline earnings management? Rev. Financ. Stud. 28, 1701–1736.
Mazzeo, M., Moore, W., 1992. Liquidity costs and stock price response to convertible security calls. J. Bus. 65, 353–369.
Mitchell, M., Pulvino, T., 2001. Characteristics of risk and return in risk arbitrage. J. Finance 56, 2135–2175.
Mitchell, M., Pulvino, T., Stafford, E., 2004. Price pressure around mergers. J. Finance 59, 31–63.
Mitchell, M., Pedersen, L., Pulvino, T., 2007. Slow moving capital. Am. Econ. Rev. 97, 215–220.
Myers, S., 1977. Determinants of corporate borrowing. J. Financ. Econ. 5, 147–175.
Myers, S., 1984. The capital structure puzzle. J. Finance 39, 574–592.
Nagel, S., 2005. Short sales, institutional investors and the cross-section of stock returns. J. Financ. Econ. 78, 277–309.
Officer, M., 2004. Collars and renegotiation in mergers and acquisitions. J. Finance 59, 2719–2743.
Officer, M., Poulsen, A., Stegemoller, M., 2009. Target-firm information asymmetry and acquirer returns. Rev. Financ. 13, 467–493.
Pinkowitz, L., Sturgess, J., Williamson, R., 2013. Do cash stockpiles fuel cash acquisitions? J. Corp. Finance 23, 128–149.
Prado, M., 2015. Future lending income and security value. J. Financ. Quant. Anal. 50, 869–902.
Prado, M., Saffi, P., Sturgess, J., 2016. Ownership structure, limits to arbitrage, and stock returns: evidence from equity lending markets. Rev. Financ. Stud. 29, 3211–3244.
Rhodes-Kropf, M., Viswanathan, S., 2004. Market valuation and merger waves. J. Finance 59, 2685–2718.
Rhodes-Kropf, M., Robinson, D., Viswanathan, S., 2005. Valuation waves and merger activity: the empirical evidence. J. Financ. Econ. 77, 561–603.
Saffi, P., Sigurdsson, K., 2011. Price efficiency and short selling. Rev. Financ. Stud. 24, 821–852.
Schneider, C., Spalt, O., 2021. Bidder and target size effects in M&A are not driven by overconfidence or agency problems. Unpublished working paper. Available at SSRN.
Shleifer, A., 1986. Do demand curves for stocks slope down? J. Finance 41, 579–590.
Shleifer, A., Vishny, R., 2003. Stock market driven acquisitions. J. Financ. Econ. 70, 295–311.
Song, M., Walkling, R., 2000. Abnormal returns to rivals of acquisition targets: a test of the acquisition probability hypothesis. J. Financ. Econ. 55, 143–171.
Travlos, N., 1987. Corporate takeover bids, methods of payment, and bidding firms' stock returns. J. Finance 42, 943–963.
Tsai, H., Wu, Y., Xu, B., 2021. Does capital market drive corporate investment efficiency? Evidence from equity lending supply. J. Corp. Finance 69, 1–26.
Uysal, V., 2011. Deviation from the target capital structure and acquisition choices. J. Financ. Econ. 102, 602–620.
Weisbach, M., 1988. Outside directors and CEO turnover. J. Financ. Econ. 20, 431–460.
Weston, J., Mitchell, M., Mulherin, J., 2014. Takeovers, Restructuring, and Corporate Governance. Pearson New International Edition. Pearson Education Limited, Harlow, Essex.
Wooldridge, J., 2010. Econometric Analysis of Cross Section and Panel Data. The MIT Press.
Wurgler, J., Zhuravskaya, E., 2002. Does arbitrage flatten demand curves for stocks? J. Bus. 75, 583–608.
Yermack, D., 1996. Higher market valuation of companies with a small board of directors. J. Financ. Econ. 40, 185–211.