

Short Selling: A Review of the Literature and Implications for Future Research

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ABSTRACT

This systematic literature review critically analyzes studies on the determinants of short selling and the implications for information distribution, real economic decisions, financial reporting, and external auditing. We select and review studies within a research framework, identifying two of the most important areas in the literature: short sellers as important information intermediaries and short sellers' influence on accounting, auditing, and other corporate decisions as the 'spillover effect' of the information distribution. Of the two, the former has a strong emphasis on financial markets, whereas the latter extends this traditional topic in finance to financial economics, corporate governance, and accounting. Our review highlights that, although short sellers use both private information and public information in selecting stocks for shorting, we know little about *how* they use private and non-financial information to influence managerial economic decisions and firms' financial reporting decisions. In discussing potential future research, we emphasize that penetrating the information 'black box' and positioning research regarding the information that short sellers use and how they use it are necessary to advance the short-selling literature.

Keywords: Short selling; Information intermediaries; Financial reporting; Corporate decisions

1. Introduction

We provide a systematic review of the voluminous literature on short-selling activity, focusing on short sellers' information gathering and dissemination roles and the way in which such activities affect real economic decisions, financial reporting, and auditing issues.¹ Short sellers sell securities that they do not own but rather borrow from a broker. Short sellers profit from the trading strategy of 'selling high and buying low.' When share prices drop later, short sellers buy back the securities and return them to the broker from whom they originally borrowed them. Therefore, the profit from this strategy depends on whether the short sellers can buy back the shares at a lower price. Early theoretical studies (e.g. Diamond & Verrecchia, 1987; Miller, 1977) indicate that, because of the cost and risks involved in short sales, short sellers will choose to short stock *only* if they believe that the stock price will decline in the future to compensate at least for the additional costs and risks.² Despite this, studies suggest that short selling constitutes a notable proportion (around 20–31 percent) of stock trades in the US equity markets (Chen, Zhu, & Chang, 2019; Diether, Lee, & Werner, 2009b). Short sales occur for a myriad of reasons that roughly fall into either informed or uninformed short-selling categories. Short sellers' belief that the stock is overvalued based on fundamental analysis motivates informed short selling (e.g. Dechow, Hutton, Meulbroek, & Sloan, 2001). To conduct informed trading, short sellers rely on the underlying economics or fundamentals of different stocks in stock selection (e.g. Dechow et al., 2001; Desai, Ramesh, Thiagarajan, & Balachandran, 2002; Engelberg, Reed, & Ringgenberg, 2012) and/or simply follow a momentum-based strategy (Curtis & Fargher, 2014; Lamont & Stein, 2004). We review this

1. The advantage of systematic reviews lies in a 'replicable, scientific, and transparent process that enables the researcher to provide an audit trail, justifying his/her conclusions' (Tranfield, Denyer, & Smart, 2003, p. 218).

2. Some examples of the costs and risks of short selling include the uptick rule, restrictions on access to proceeds from short sales, unlimited loss with increases in the stock price, legal constraints on short selling by certain institutions, and negative rebate rates (Diamond & Verrecchia, 1987). Engelberg, Reed, and Ringgenberg (2018) use variance of lending fees as a proxy for short-selling risk and find that higher short-selling risk is associated with lower future returns, decreased price efficiency, and less short-selling activity by arbitrageurs.

strand of the literature because it pertains to information acquisition and distribution, highlighting short selling's profound implications for economic decisions and financial reporting. Meanwhile, financial markets have witnessed the development of a new type of short sellers, commonly known as activist short sellers (Paugam, Stolowy, & Gendron, 2020; Zhao, 2020). Well-known examples include *Citron Research*, *Copperfield Research*, *Glaucus Research*, *Gotham City Research*, *Iceberg Research*, and *Muddy Waters Research*. The emerging literature suggests that activist short sellers play a key role in policing financial markets, revealing financial manipulation and accounting fraud.³

A smaller subset of papers investigates the role of uninformed short sellers executing market-neutral arbitrage strategies—for example investors or portfolio managers undertaking short selling to hedge against the downside risk of a long position (Ederington, 1979) and shorting shares in the acquiring firm's stock in a merger situation while going long in the target firm's stock (Baker & Savaşoglu, 2002). Investors may also undertake short sales to arbitrage a price differential between the stock and the debt convertible into the stock (Duca, Dutordoir, Veld, & Verwijmeren, 2012). However, we exclude this stream of the literature from our review, as Reed (2013) provides excellent coverage of such research.

Research on short selling reveals short sellers' price discovery roles and highlights their ability to exploit *public* information to facilitate their financial statement analysis and stock valuation (e.g. Ackert & Athanassakos, 2005; Aitken, Frino, McCorry, & Swan, 1998; Asquith, Pathak, & Ritter, 2005; Au, Doukas, & Onayev, 2009; Boehmer, Jones, & Zhang, 2008; Desai et al., 2002; Diether, Lee, & Werner, 2009a; Duffie, Garleanu, & Pedersen, 2002; Lynch, Nikolic, Yan, & Yu, 2014; Sobaci, Sensoy, & Erturk, 2014; Takahashi, 2010). Extending this

3. Zhao (2020) finds that *activist* short sellers tend to target opaque firms that experience about three times as negative abnormal returns in both the short and the long term as non-opaque targets. Although this evidence is suggestive of informative shorts, Zhao (2020) also finds that opaque targets experience more dramatic price reversals, particularly when there is a substantial initial drop in targets' prices immediately after the attacks: evidence of manipulative short selling.

traditional literature, the research further advances our knowledge, showing substantial *private* information acquisition by short sellers prior to negative information events (e.g. the public revelation of financial misconduct, the announcement of accounting restatements, stock downgrades, bond rating downgrades, and so on) and the profitability of such trading strategies (see sections 3.1 and 3.2 for a detailed review of this literature). With an improved research design and the availability of high-frequency daily short-trading data around specific corporate news events, this stream of literature provides direct evidence on (i) the types of negative news on which short sellers trade; (ii) the precise timing of the trading; and (iii) the profitability of the specific event-based trading strategy.

Meanwhile, a new stream of literature explores whether short-selling interests affect corporate decision making. For example, managers react to short-selling pressure by modifying their financing and investing decisions (Grullon, Michenaud, & Weston, 2015) and improving managerial compensation pay-for-performance sensitivity (DeAngelis, Grullon, & Michenaud, 2017). In a similar vein, studies demonstrate that managers attempt to improve their financial reporting quality in the presence of high short interest. Collectively, this stream of literature recognizes the dynamic interactions between short sellers as market participants and corporate financing, investing, contracting, and financial reporting decisions.

Our review also identifies some gaps in the short-selling literature and highlights some inherent challenges that researchers face in their research designs. First, it is possible to enrich further the literature on the motivations behind short sellers' stock coverage decisions. It is unclear whether short sellers have profound knowledge of firms' corporate governance mechanisms, problematic corporate strategies, and other indicators of corporate long-term operational 'red flags' when selecting stocks for shorting. Although corporate governance is of paramount importance in corporate operations and firm performance, it is an under-researched

area in the short-selling literature, and we identify a lack of direct investigation of short sellers' knowledge of and trading on (suboptimal) corporate governance practices.

Meanwhile, although a plethora of research confirms short sellers' superior ability to collect and process both public and private information, we know little about the source of such information and the means by which sellers obtain such private information. A few papers (Berkman, McKenzie, & Verwijmeren, 2016; Christophe, Ferri, & Hsieh, 2010) reveal that short sellers receive tips from insiders and financial analysts, thereby enabling them to front run those parties and take a short position before the revelation of the negative information to the public. We believe that this offers a promising avenue for further research.

In addition, researchers studying short selling face a few inherent technical challenges, such as self-selection bias and potential reverse causality. Recent studies advance the research methods by utilizing the US short-selling Regulation SHO (Reg SHO hereafter) and the regulatory short-selling regimes in China's and Hong Kong's equity markets as exogenous shocks for conducting difference-in-difference (DiD) tests to draw causal inferences. These tests, despite being fruitful in overcoming reverse causality, are essentially restricted to a few markets that enforce the regulations. We make recommendations for a more innovative research design for future research.

The available literature (both theoretical and empirical) on short selling, published in accounting- and finance-related journals, is voluminous. To ensure the quality of the reviewed papers, we select studies published between 1967 and 2020 in journals that are ranked B and above in the Australian Business Dean Council's (ABDC) 2019 journal rankings.⁴ Seneca

4. We find a high degree of overlap in the journal rankings in the accounting and finance field in the ABDC and the Association of Business Schools (ABS) journal rankings. The ABDC tends to be a more inclusive list, and we decide to follow the ABDC ranking (ABDC, 2019; ABS, 2018). For a complete list of journals of the ABDC and ABS ranking systems, please see ABDC 2019 Journal Rankings, retrieved from <https://abdc.edu.au/research/abdc-journal-list/2019-review/>; Last accessed: June, 18, 2020, and ABS 2018 Journal Rankings, retrieved from <https://charteredabs.org/academic-journal-guide-2018/>; Last accessed: June, 18, 2020.

(1967) appears to be the first study on short selling that views short sales as a predictor rather than a causal variable of the stock price. In searching for articles, we use a series of keywords, including ‘short sale(s),’ ‘short selling,’ ‘short interest(s),’ ‘short sellers,’ ‘short selling threat(s),’ ‘shorting,’ and ‘Regulation SHO’ in databases like EBSCOhost, Emerald Insight, Scopus, Web of Science, Google Scholar, and the Social Science Research Network (SSRN). Collectively, we identify a total of 149 papers, of which 95 investigate the information intermediary effects of short-selling activities (section 3) while 21 explore the effect of short selling on managerial real economic decisions and financial reporting issues (section 4). We find that 94 of the papers appear in A*-ranked, a further 38 papers in A-ranked, and 5 in B-ranked journals. We include a total of 12 working papers in our review. Working papers pose a challenge because of their sheer number and because they have not undergone peer review. We choose a subset of papers that have been presented at top conferences or are influential in the field.

We organize the remainder of the review as follows. Section 2 describes the controversies surrounding short-selling activities, the measurement proxies used, and the regulations concerning short selling. Section 3 reviews papers examining the information that short sellers use, the characteristics of the stocks that short sellers target, and the information effect of short selling on the stock markets. Section 4 reviews the empirical literature on the real effects of short selling on managerial decisions (section 4.1) and the disciplinary effect of short selling on financial reporting decisions and external auditing (sections 4.2 and 4.3). Section 5 discusses the technical problems in the current short-selling studies and makes suggestions for future research. Section 6 concludes this review. It is to be noted that we prepare four tables using online appendices to present more detailed information about the research issues, sample, and findings of the papers reviewed in the main sections. The specific table is mentioned in the pertinent section.

2. Short- Selling Activities: Controversies, Measurements and Regulations

2.1. Short Sellers: Are they the Good, the Bad or the Evil?

Evidence on whether short sellers are informed is important, because it is relevant when assessing the potential cost, through loss of value-relevant information, of restricting short sales (Diamond & Verrecchia 1987) and at the same time when evaluating the potential benefit of higher-frequency disclosures of short sales (Aitken et al., 1998; Christophe, Ferri, & Angel, 2004). A large strand of literature intensively debates the role of short sellers in the financial market. One school of thought argues that short sellers are sophisticated investors, playing an important role in price discovery and stock market efficiency and disciplining corporate managers, because they collect information from a variety of public and private information sources (Boehmer et al., 2008; Christophe et al., 2004, 2010; Diether et al., 2009b).⁵ Opponents of such a favorable view argue that short sellers are uninformed and predatory traders who play a detrimental role in the society by manipulating stock prices, inducing market volatility, generating unwanted selling pressure, and limiting market efficiency (Allen & Gale, 1992; Brunnermeier & Oehmke, 2014; Goldstein & Guembel, 2008; Ljungqvist & Qian, 2016).⁶ However, as we will detail in section 3, the extant evidence supports the notion that short sellers are collectively informed and possess superior information to other market players.

5. For example, former short-selling expert Kathryn Staley (1996) notes in her book *The art of short selling* that ‘Short sellers accumulate volumes of disparate facts and observations then they make an intuitive leap based on the information at hand. Frequently, the signs point to large problems that will not be revealed in total until after the collapse.’ In a similar manner, James Chanos, President of Kynikos Associates, in his testimony before the Securities and Exchange Commission (SEC) Roundtable on Hedge Funds, mentions that, before choosing stocks for short sale, his firm (Kynikos Associates) pursues a rigorous financial analysis and focuses on securities issued by companies that seem to have (i) materially overstated earnings; (ii) an unsustainable or operationally flawed business plan; and/or (iii) engaged in outright fraud. <https://www.sec.gov/spotlight/hedgefunds/hedge-chanos.htm>; Last accessed: June, 18, 2020.

6. Brunnermeier and Oehmke (2014) provide a model that shows that temporarily depressed stock prices from short selling force a financial institution to fire sell long-term assets to repay debt and satisfy the leverage constraint. Such losses allow predatory short sellers to make a profit on their short positions.

2.2. Regulations or non-Regulations: A Dilemma

Given the controversies surrounding short-selling activities, the regulations aiming to restrict such activities are sporadic and often prompted by financial crises or a credit crunch to help stabilize the market. Hence, the removal of ‘shorting bans’ is often experimental in nature. For instance, the regulator in the US has adopted different forms of short-selling restrictions over the years, including the uptick rule (allowing shorting only when the price is at least a tick higher than the previous trade), which it introduced in 1934 but revoked in 2007; the short-selling ban of 797 financial stocks during the financial crisis of 2008; Rule 201 of Reg SHO (allowing only limited orders to sell short after a 10 percent intraday decline in a stock’s price); and SEC Rule 105 of Regulation M (prohibiting the purchase of securities in follow-on and secondary offerings when the purchaser has effected short sales in the securities within a specified amount of time prior to the pricing of an offering) (Brunnermeier & Oehmke, 2014; Jones, 2012; Shkilko, Ness, & Ness, 2012). Likewise, a number of international financial regulators have taken measures against short selling. For example, in August 2011, in the midst of the European sovereign debt crisis, regulators in France, Spain, Italy, and Belgium imposed temporary bans on short selling for some financial stocks (Brunnermeier & Oehmke, 2014). In the equity markets in mainland China and Hong Kong, only designated securities are eligible for short selling (Bai & Qin, 2014; Chang, Cheng, & Yu, 2007; Zhao, Li, & Xiong, 2014).⁷

Despite the intention behind regulatory restriction of short selling as a means of alleviating the severity of market panic, studies report mixed findings in relation to the benefits

7. Short sales were restricted in mainland China until March 31, 2010, when a pilot scheme permitted 90 designated stocks to engage in short selling in China’s A-share markets to improve information efficiency. Short-selling activities have been on the rise since the Chinese Government relaxed the short-sale restriction on stocks in 2010 (Jin et al., 2018). Hong Kong lifted restrictions on short sales after January 1994 and has been identifying eligible stocks for shorting every year through a selection mechanism ever since (Chang et al., 2007).

of short-selling restrictions. Proponents of short-selling restrictions find that temporary and targeted short-sale restrictions on the stocks of vulnerable institutions can save these institutions (Brunnermeier & Oehmke, 2014). Examining the regulations and feasibility of short selling in 46 equity markets around the world, Bris, Goetzmann, and Zhu (2007) show that market returns display significantly less negative skewness when short selling is either prohibited or not practiced. Anecdotal evidence also suggests that stock exchanges and their listed firms seek protection against short sales and therefore oppose the removal of short-selling constraints (He & Tian, 2015). For instance, Lamont (2012) finds that firms deliberately switch stock exchanges to seek protection against short sellers.

However, overwhelming evidence suggests that short-selling restrictions/constraints distort the market efficiency by slowing down the incorporation of negative private information (e.g. Choy & Zhang, 2019; Danielsen & Sorescu, 2001; Ho, 1996; Hasan, Massoud, Saunders, & Song, 2015; Shyu, Chan, & Liang, 2018), which in turn causes overvaluation⁸ and bubbles. Short-selling restrictions also reduce hedging's effectiveness (Brunnermeier & Oehmke, 2014; Chang et al., 2007; Zhao et al., 2014), adversely affect the option markets, as evidenced by a significant increase in option bid-ask spreads for banned stocks relative to unbanned stocks (Grundy, Lim, & Verwijmeren, 2012), and tend to be associated with IPO underpricing (Boulton, Smart, & Zutter, 2020). Bris et al. (2007) also demonstrate that stocks incorporate negative information faster in equity markets in which short sales are allowed and practiced, highlighting the benefits of removing short-sale restrictions. Using a regulatory change in China as a quasi-natural experiment, Ni and Zhu (2016) document that, when short-selling

8. Although Miller (1977) hypothesizes that dispersion of investor opinion in the presence of short-sale constraints leads to stock price overvaluation, empirical tests of Miller's hypothesis examine the valuation effects of only one of these two *necessary* conditions. For example, Figlewski (1981) finds some weak evidence that more heavily shorted firms underperform less heavily shorted firms using a limited sample from 1973 to 1979. Although his *least* shorted firms produce *positive* abnormal returns with statistical significance, his *most* shorted deciles do not produce significant negative abnormal returns. However, Boehme, Danielsen, and Sorescu (2006) find strong evidence of significant overvaluation for stocks that are subject to *both* conditions simultaneously. However, Mashruwala and Mashruwala (2018) provide evidence supporting the beneficial effect of accounting conservatism in reducing overvaluation for firms with the highest short-selling constraints and investor disagreement.

constraints are removed, more unrevealed negative information is incorporated into the stock price, which leads to a stock price crash.

To conclude, quantifying the welfare effect of prohibiting short sales is remarkably complex, owing to (1) the substitutive nature of the benefits and the costs of short-selling bans, in that the bans on short selling reduce trading activity but do not increase transaction costs, (2) the short-term effects being different from the long-term equilibrium, that is, lower trading activity as a result of a ban is a permanent effect while higher transaction costs are a temporary phenomenon (Lensberg, Schenk-Hoppé, & Ladley, 2015), and (3) bans on short selling often occurring in times of extreme market circumstances and, therefore, not being completely exogenous, which complicates the ‘keeping all else equal’ requirement in the design of an empirical study.⁹ Given that short sales contain valuable firm-specific information and convey an information signal to uninformed investors who buy on the margin (Shyu et al., 2018), regulators should rather encourage and/or mandate stock exchanges to disclose short-selling activities more frequently (Liu, Ma, & Zhang, 2012).

2.3. Measurements

The extant studies use various measures to assess short-selling activities. These measures, however, differ little in terms of the underlying construct. One of the most widely used measures of short-selling intensity is the ratio of the short-selling volume to the total trading volume. This measure captures the regular trading volume and is less skewed than other measures (see Christensen, Drake, & Thornock, 2014; Diether et al., 2009a). Another commonly used short-selling measure is the ratio of the number of shares sold short to the number of shares outstanding. This measure of short selling performs well in capturing deviations in the unconditional short volume (Senchack & Starks, 1993; Shkilko et al., 2012).¹⁰

9. We acknowledge one of the reviewers for this insightful comment.

10. Using short interest as a proxy for shorting demand, however, is problematic, because the quantity of shorting represents the intersection of supply and demand. The quantity of shorting should respond to both the

A few studies use alternative measures of short selling that differ to some extent from the above two measures. For example, Lamont and Stein (2004) use the value-weighted short-interest ratio (i.e. the market value of shares sold short scaled by the value of shares outstanding). In addition, given that, on the New York Stock Exchange (NYSE), specialists who are involved in high-frequency trading for hedging execute a large proportion of short-selling transactions, the authors calculate short selling for the NYSE as the number of shares that public investors (as opposed to NYSE member firms) sell short divided by the total share volume. Ni and Zhu (2016) use an indicator variable that takes the value of one if the stock of a particular firm is on the short-sales list and zero otherwise.

To capture properly the undisclosed private information embedded in short selling, some recent studies (e.g. Bao, Kim, Mian, & Su, 2019; Cheng, Shyu, & Wang, 2019) measure short-selling interest using the residual short interest, which they estimate as the residuals from the following regression:

$$SIR = \beta_0 + \beta_1 IO + \beta_2 CONVERT + \beta_3 TREND + \xi \quad (1)$$

where *SIR* is the shares on loan to short sellers relative to the market capitalization of the stock; *IO* is the institutional ownership; *CONVERT* is a dummy variable that takes the value of one when a firm has convertible bonds or convertible preferred stock and zero otherwise; and *TREND* is the time trend variable. The studies incorporate these variables to isolate the effects of the supply of loanable shares, hedging-based shorting, and variation over time in the average shorting costs that are not related to the existence of firm-specific negative private information (Bao et al., 2019).

cost and the benefit of shorting the stock, so stocks that are very costly to short will have low short interest. Impossible-to-short stocks have an infinite shorting cost, yet the level of short interest is zero. Thus, short interest can be negatively correlated with the shorting demand, overpricing, and shorting costs (Lamont, 2012).

In the spirit of the above measure, Purnanandam and Seyhun (2018) use a standardized measure of shorting to account for the demand for information-based short selling. They calculate this standardized measure as follows:

$$SHORT\ INTEREST = \frac{\left(\frac{SI}{SO}\right)_t - \mu\left(\frac{SI}{SO}\right)}{\sigma\left(\frac{SI}{SO}\right)} \quad (2)$$

where SI/SO is the scaled short-interest ratio. The authors claim that, by construction, this measure reflects the deviation from the average level of shorting of a stock after accounting for its variance.

The above-discussed measure may not capture short-selling activities around firm-specific events. Therefore, some studies estimate abnormal short interest (short spikes) around corporate-specific events (e.g. earnings announcements, analyst downgrades, seasoned equity offerings, and corporate misconduct) as the difference between the short-interest ratio (e.g. the ratio of the short volume to the total trading volume) and the average short-interest ratio over a benchmark period¹¹ (Chen, Kadapakkam, & Yang, 2016; Christensen et al., 2014; Christophe et al., 2004, 2010). For example, Chen et al. (2016) estimate the abnormal short turnover as:

$$Abnormal\ short\ turnover_{i,t} = \frac{short\ volume_{i,t}}{trading\ volume_{i,t}} - \frac{average\ short\ volume\ over\ (t-40,t-15)}{average\ trading\ volume\ over\ (t-40,t-15)} \quad (3)$$

A few recent studies (e.g. Beneish, Lee, & Nichols, 2015; Chang, Lin, & Ma, 2019) exploit a new dataset from Markit Data Explorer (DXL) that provides equity lending data from more than 100 institutional lenders, which collectively represent the largest pool of loanable equity inventory in the world. Using this comprehensive dataset, Beneish et al. (2015) measure short-selling intensity as the total shares that DXL lenders borrowed divided by the total shares

11. The benchmark period consists of all the trading days in the short volume dataset that do not fall within an 11-day earnings announcement period window (Christophe et al., 2004).

outstanding (also see Chang et al., 2019; Massa, Zhang, & Zhang, 2015; Saffi & Sigurdsson, 2011).¹²

Studies also differ on the use of the frequency (e.g. daily and monthly) of short-selling data. It is important to emphasize that the daily short-sale volume is different from the monthly short interest with respect to its ability to capture underlying phenomena. For example, the monthly short interest reflects information about longer-term firm fundamentals and therefore is more suitable for examining the information efficiency of short-selling activities (Comerton-Forde, Do, Gray, & Manton, 2016; Diether et al., 2009b). On the other hand, daily short-sale volume data capture intra-month shorting and can quantify the magnitude and timing of short-selling activity more precisely. Therefore, daily short-sale volume data permit more powerful and accurate tests than the monthly frequency of short-interest data to study short-term trading strategies such as index arbitrage, convertible bond arbitrage, and merger arbitrage (Comerton-Forde et al., 2016; Diether et al., 2009b; Liu & Wu, 2014). Thus, given the availability of different short-selling measures and the unique information content of these alternatives, a deeper understanding of the strength of alternative measures and the purpose of the inquiry is a prerequisite for a well-designed short-selling study.¹³

3. Short Sellers as Important Information Intermediaries

A large body of research examines short sellers' information role in equity markets. Supporting the notion that short sellers are informed traders, studies report that short sales or short interest predict and precede future stock price underperformance and increase the market efficiency

12. Beneish et al. (2015) consider 'limits to the supply of lendable shares' as a key impediment to pricing efficiency. However, Reed (2015) argues that this may not be the case, as the supply of available shares is closely related to other variables, like the demand and price for borrowing, quantity borrowed, and short interest. Therefore, Reed (2015) suggests that 'supply should not be considered as a completely independent view of the equilibrium relationship among quantity, price, and demand' (p. 97).

¹³ Table A4 (see online appendices) summarizes the papers reviewed in Section 2 that are mainly in the areas of short selling regulations and are not included in Table A1-A3.

and price discovery of overvalued stocks. For example, Rapach, Ringgenberg, and Zhou (2016) find that short sellers are informed traders who can anticipate future aggregate cash flows and associated market returns. We now review the strand of the literature that examines the price discovery function stemming from short-selling activities. For ease of exposition, we categorize such research into three broad themes, namely (i) the information sources that short sellers use; (ii) the characteristics of the securities that short sellers target; and (iii) the information superiority and the effect of short sellers' information dissemination on the capital markets. Table A1 (see online appendices) shows the papers reviewed in this section.

3.1. The Information Sources of Short Sellers

The extant literature offers two major explanations for the superiority of short sellers' stock valuation abilities: the public and private information hypotheses. The public information hypothesis conjectures that short sellers are sophisticated investors with superior capability in processing publicly available information accurately and efficiently. The private information perspective suggests that short sellers' information advantage may derive from their acquisition of private information that is not accessible to all the market participants (e.g., Anderson, Reeb, & Zhao, 2012; Christophe et al., 2010).

3.1.1. Public Information Perspective

It is well accepted that short sellers target firms with overpriced stocks and lower expected future returns and that they base the stock valuation on fundamental analysis (Dechow et al., 2001; Desai et al., 2002; Engelberg et al., 2012). Like other information users, short sellers, in predicting future stock returns, calculate and compare the 'intrinsic' values based on accounting data in relation to the market value. As expected, it is documented that short sellers

target securities with low fundamental-to-price ratios and then unwind their positions as these ratios revert to their normal levels (Cheng, Yan, Zhao, & Chang, 2012; Dechow et al., 2001). Furthermore, short sellers can differentiate between low ratios as a result of temporarily low fundamentals due to non-recurring items and low ratios that are attributable to temporarily high prices, and they only target firms with the latter characteristic (Dechow et al., 2001).

Similarly, Engelberg et al. (2012) find that short sellers' ability to analyze publicly available information contributes substantially to their information advantage, but they obtain only weak evidence that short sellers anticipate firms' forthcoming news events. Deshmukh, Gamble, and Howe (2015) conclude that short sellers predict future negative operating performance but do not address the question of whether the superior information is due to short sellers' utilization of public information or the acquisition of private information.

Drake, Rees, and Swanson (2011) divide information into four categories captured by 11 variables based on publicly available information about firms and investigate whether short sellers have better comprehension of these variables than financial analysts.¹⁴ They reveal that short sellers interpret all 11 variables properly in accordance with how those information variables affect future stock returns, whereas analysts fail to do so. Drake et al. (2011) point to the difference in information-processing abilities between financial analysts and short sellers, serving as an exemplar of advancement in short-selling research. Hobbs, Keasler, and McNeil (2012) document that short sellers are able to exploit the behavioral biases associated with overpricing events, such as the airing of the television show 'Mad Money,' which provides a large number of buy recommendations in a typical month.

3.1.2. Private Information Perspective

14. The four information categories include *accounting* (earnings surprise, accruals, and capital expenditures), *valuation* (market value of equity, earnings-to-price ratio, book-to-market ratio, and average daily stock turnover), *growth* (sales growth and forecasted long-term growth), and *momentum* (earnings forecast revision and price momentum).

Since short sellers are sophisticated information users, we would expect them to seek and utilize information that is non-financial or not publicly available. For instance, studies report short sellers' informational advantage in identifying and shorting stocks of firms that experience subsequent public revelation of financial misconduct (Karpoff & Lou, 2010), accounting restatement announcements (Desai, Krishnamurthy, & Venkataraman, 2006), bond rating downgrades (Henry, Kisgen, & Wu, 2015), credit rating downgrades (Shi, Wang, & Zhang, 2017), financial analysts' stock downgrades (Christophe et al., 2010; Meng, Li, Jiang, & Chan, 2017), large insider sales (Chakrabarty & Shkilko, 2013), private placements (Berkman et al., 2016), and asset write-downs (Liu et al., 2012).

First and foremost, short sellers are able to detect accounting irregularities. Dechow, Sloan, and Sweeney (1996) report an increase in short interest in the two months before SEC-initiated Accounting and Auditing Enforcement Releases (AAERs) for a sample of firms. Studying firms that the SEC disciplined for financial misrepresentation between 1988 and 2005, Karpoff and Lou (2010) demonstrate an abnormal short-interest rise in the 19-month period immediately before the misrepresentation announcements, which is positively related to the severity of misconduct and the levels of accrual manipulation. Desai et al. (2006) report that the accumulation of short interest in restating firms prior to the restatement announcement is large compared with that in non-restating firms, especially for restating firms with high levels of accrual manipulation. Nevertheless, Drake, Myers, Scholz, and Sharp (2015) find that short sellers seem *not to anticipate* restatement announcement dates, although abnormal short selling is significantly higher than normal when firms announce restatements.¹⁵

A bond rating downgrade affects equity returns adversely (Goh & Ederington, 1993), so Henry et al. (2015) propose that short sellers have an incentive to seek information pertinent

15. Drake et al. (2015) use daily short volume data over short windows around restatement announcements as opposed to the monthly short interest data that Desai et al. (2006) use. The use of short window data 'increases the likelihood that short-seller activities are directly related to the restatement characteristics rather than to other information about earnings quality' (pp. 220–221).

to rating downgrades. As expected, they find that short sellers use firms' bond credit rating-specific information to identify the bond rating downgrades and take the short position in advance of such downgrades. The authors further demonstrate this effect to be stronger after the passage of Regulation FD: evidence suggesting that short sellers have a greater private information advantage when other private information communication with the firm is restricted. Furthermore, as a result of the short sale, firms experiencing rating downgrades shorten their post-downgrade negative equity return drift, suggesting faster price discovery driven by short sales. Despite Henry et al.'s (2015) finding on short sellers' use of bond rating-related information in a way similar to a credit agent, they do not directly address the question of whether short sellers collect public vs. private and/or financial vs. non-financial information pertinent to bond rating or how short sellers obtain that information.

Shi et al. (2017) observe a stronger increase in short-selling interest prior to a credit review announcement relative to a rating downgrade announcement, as the latter would be well anticipated by the market participants following a prior negative credit review announcement. The findings therefore support short sellers' use of the private information that the rated firms provide.¹⁶

Christophe et al. (2010) find elevated short selling in the days immediately preceding a stock downgrade announcement. They argue that this phenomenon is a result of short sellers having private information—a tip from the brokerage house about the exact day of the downgrade announcement—and establishing short positions accordingly. Although their finding of short sellers' use of tips does not rule out the possibility that short sellers, like analysts, use the same valuation-relevant public information to assess the financial health of a

16. For example, Moody's 2002 Special Comment (Fons, Cantor, & Mahoney, 2002, p. 5) states: 'Moody's will use confidential non-public information that issuers provide to Moody's only for the purpose of assigning ratings. Moody's will not, without the permission of the issuer, disclose the information in the press release or other research reports published in connection with the rating, or in discussions between Moody's analysts and investors, or other issuers ... Moody's believes that the efficiency of capital markets is best served by permitting issuers to disclose to rating agencies material non-public information for use solely in rating decisions.'

firm, additional tests lend credence to the tipping hypothesis. Meng et al. (2017) obtain similar findings for firms that star analysts follow but not for those that non-star analysts follow in the Chinese stock market.

Similarly, Chakrabarty and Shkilko (2013) and Khan and Lu (2013) both document positive abnormal short sales leading up to large insider sales. They conclude that the information leakage from brokerages that execute insider sales explains short sellers' 'front run' of inside trading. Particularly, Chakrabarty and Shkilko (2013) find consistent evidence that short sellers have knowledge not only of the insider's rank but also of the unobservable size of the insider's trading position, although the results do not rule out the possibility that some of short sellers' information about insider sales is also due to their ability to analyze the visible order flow, suggesting that short sellers use all the information, including the order flow of other investors on the market, to make trading decisions.

Berkman et al. (2016) also observe the information leakage of insiders to short sellers, revealing a significant increase in the average short interest surrounding the preannouncement of stock private placements.¹⁷ Such an effect is more pronounced when more buyers are involved in the private placements. Additionally, using insider trading activities as a measure of private information in stocks, Purnanandam and Seyhun (2018) find that short-selling activities are considerably informative about future stock returns when there is a higher likelihood of insider trading. Short sellers also bring considerable additional information to the market that contemporaneous insider trading does not fully capture.

Liu et al. (2012) document that short sellers accumulate short positions prior to asset write-down announcements and that stocks experience significantly negative returns around such announcements, suggesting short sellers' informational advantage. Furthermore, short

17. Firms often engage in confidential conversations with potential investors (e.g. hedge funds) before the public announcement of the private placement of their shares. The Securities Act in the US prohibits insiders who have received private information during these conversations from trading.

sellers increase their positions significantly in the announcement month and keep increasing their positions afterward, suggesting a feedback effect. Akbas, Boehmer, and Erturk (2017) find that the ability of short sellers to predict future bad news, negative earnings surprises, and downward revisions in analyst earnings forecasts provides an explanation for their discovery of unfavorable information about firms. However, the study does not reveal the source of information that short sellers use to facilitate their understanding and prediction.

Collectively, the aforementioned evidence suggests that short sellers use both public and private information to facilitate stock valuation and that they are not mutually exclusive. However, the evidence on private information acquisition and the sources through which they obtain different private information requires additional investigation. This is complicated by the fact that the private information acquisition phenomenon is often unobservable, researchers having little or no access to such sources. An innovative study by Massoud, Nandy, Saunders, and Song (2011) investigates short sellers' use of private information when hedge funds short shares of highly leveraged firms with lower credit quality to which they lend money. This type of short selling takes place prior to public announcements of both loan originations and loan amendments, strongly pointing to short sellers' exploitation of their private information in this scenario.

3.2. Characteristics of the Securities that Short Sellers Target

Dechow et al. (2001) find consistent evidence that short sellers tend to follow firms with a low fundamental ratio, a large market value, and a high institutional shareholding. Christophe et al. (2004) find similar evidence of informed shorting in pre-earnings announcements in stocks with low book-to-market valuations. In addition, short sellers are typically more active in small-cap stocks as opposed to medium- or large-cap stocks (Boehmer et al., 2008). Sloan (1996) mentions the hypothetical long/short hedge portfolio based on accruals but does not

provide evidence that short sellers really target firms with high accruals. Richardson (2003) tests this proposition empirically but fails to find evidence that short sellers target firms with high accruals. Geczy, Musto, and Reed (2002) indicate that short sellers follow well-accepted trading strategies based on factors such as size, book-to-market, and momentum effects.¹⁸ Previous research also reports dividend payments, company fundamentals, risk, option trading, the interest rate spread, and past returns to be significant determinants of short selling in Hong Kong (McKenzie & Henry, 2012).

Boehmer, Huszar, and Jordan (2010) demonstrate that heavily shorted portfolios underperform over the subsequent month whereas lightly shorted stocks generate significant positive abnormal returns in the US. Nevertheless, Andrikopoulos, Clunie, and Siganos (2012) reveal that heavily shorted firms in the UK do not necessarily underperform their lightly shorted counterparts. In fact, short sellers' ability to predict future firm performance is limited to firms that struggle for survival, such as firms that are about to fail or financial firms during the financial crisis.¹⁹ One plausible explanation for the contradictory findings between the US and the UK studies might be related to the rather lax regulatory constraints in the UK market, which might increase less motivated (uninformed) traders' short selling compared with that in US markets, in which stringent regulatory requirements for short selling may result in the participation of a large proportion of informed short sellers.

18. Geczy et al. (2002) also find that, while average borrowing costs are initially elevated for IPOs, they appear to be insufficient to explain the long-run underperformance of IPOs. Edwards and Hanley (2010) find evidence of active short selling in the first trading week of IPOs, a finding that is inconsistent with the notion that short-sales constraints are binding in the immediate aftermarket. However, Patatoukas, Sloan, and Wang (2020) predict and find that the IPOs that are the most susceptible to overpricing (using accounting measures of valuation uncertainty as a proxy) have first-day sizable returns of +44 percent but lockup expiration returns of -10 percent. They also find that these IPOs experience severe short-sales constraints that peak around the lockup expiration. With respect to the informational efficiency of short sellers around seasoned equity offerings (SEOs) announcements, Deshmukh, Gamble, and Howe (2017) find that firms with large increases in short interest prior to the SEO announcement exhibit more negative announcement period returns and inferior long-term operating and stock price performance following the equity issue. However, using daily short-selling data around seasoned equity offerings (SEOs), Henry and Koski (2010) find no evidence of informed short selling, which is consistent with manipulative trading.

19. Au et al. (2009) also reveal that heavily shorted firms underperform their lightly shorted counterparts, although the magnitude of this underperformance using equal and value-weighted returns is only 0.59 percent and 0.19 percent per month, respectively, which is much lower than that reported in the US.

Anderson et al. (2012) state that family firms, both founder and descendent controlled, could be a source of information leakage, providing outside investors with information to engage in short sales. They demonstrate that family firms that were among the 2000 largest US industrial firms at the beginning of 2004 experienced substantially higher abnormal short sales before negative earnings shocks than non-family firms. In addition, the future abnormal stock returns of family firms decreased in short-selling activity, suggesting that short-selling interest provides useful information for forecasting abnormal returns for family firms.

Another strand of the literature finds that firms with poor financial reporting quality tend to attract short sellers. Karpoff and Lou (2010) report that short sellers are aware of the financial reporting quality and profit from shorting stocks with low financial reporting quality. Focusing on real earnings management, Park (2017) reveals that firms with more real earnings management activities increase the subsequent short-selling interest, as real earnings management results in the overvaluation of stocks, a feature that attracts short sellers. Cheng et al. (2019) document that short sellers are interested in firms with less comparative accounting information (a proxy for poor reporting quality) but also find that ex-ante short-selling pressure improves future accounting comparability. Singer, Wang, and Zhang (2018) find that short sellers target firms that are about to disclose first-time internal control material weaknesses (ICMWs) under Section 404 of the Sarbanes–Oxley Act, courtesy of their use of mainly private rather than public information. Furthermore, the ability of short sellers to predict ICMWs is more pronounced in firms operating in an environment with high information asymmetry. Meanwhile, Christensen et al. (2014) reveal that firms disclosing pro forma earnings at the time of earnings announcements tend to have a significantly larger short-selling volume than their counterparts without adjusted earnings metrics in the earnings announced. The finding suggests that pro forma disclosures give rise to information asymmetries that provide short sellers with an informational advantage. Jain, Jain, and Robin (2019) document a negative and significant

relationship between short selling and accounting conservatism. Conditional conservatism, by accelerating the recognition of bad news, reduces the possibility of a substantial stock price decline in the future, the very notion from which short sellers make a profit. They rule out the reverse causation concern that short-selling interest triggers conservatism by exploiting Reg SHO, documenting that increased short selling during the regulatory period does not affect conservatism.²⁰

Short sellers are also able to detect and short stocks hoarding bad news to make a profit accordingly. Consistent with this proposition, Callen and Fang (2015) document that short-selling interest is positively related to a one-year-ahead stock price crash risk. Meanwhile, short sellers profit from shorting firms with a high book–tax difference (BTD) that other investors often misprice (Chi, Pincus, & Teoh, 2014). The authors demonstrate that short sellers can profit from taking a short position in firms with a high BTD to exploit the overpricing because of their ability to detect likely upward earnings management and overvaluation in firms with a high BTD. Jain, Jain, and Rezaee (2016) document a negative association between short interest and firms’ economic, social, and governance (ESG) performance, implying that short sellers are interested in analyzing firms with unique ESG challenges that make their reported financial statements less reliable and less transparent to the average uninformed investor.

Blau, Brough, Smith, and Stephens (2013) investigate whether short sellers can (a) distinguish between ‘good news’ and ‘bad news’ signals associated with the various types of auditor change and (b) improve their trading revenue by shorting stocks of companies that signal ‘bad news’ auditor changes. They find that short-selling activity increases significantly on and shortly after the announcement²¹ of auditor changes relating to auditor downgrades,

20. However, short selling also provides an external governance mechanism to monitor managers and to facilitate information transparency, a view that Jin, Lin, Yang, and Zhang (2018) test and confirm using data from China.

21. The choice of selecting post-announcement period short-selling activity is premised on the empirical findings that short sellers react strongly to pro forma earnings announcements (Christensen et al., 2014). Such evidence implies that short sellers could be more reactive than proactive and hence might exhibit abnormal shorting activity during the post-announcement period, particularly for unfavorable announcements.

auditor resignation, and auditor–client disagreement. They also document significantly higher short-selling revenues during the post-announcement period related to auditor downgrades and auditor resignation signals.

Pownall and Simko (2005) examine firms that experienced abnormal short interest increases (short spikes) during the period 1989–1998, finding that the mean abnormal return around short spike announcements is significantly more negative for firms with a low analyst following. Since the stock prices of firms with a low financial analyst following tend to incorporate information about future earnings slowly (Ayers & Freeman, 2003), the information asymmetry is high in those firms. Following this line of inquiry, future research might identify and examine the contexts in which information asymmetry is severe and short sellers may complement the traditional sources of information intermediaries to facilitate information dissemination. For instance, when firms experience a different operational environment and economic and political uncertainty, they may have a high degree of information asymmetry. It is worthwhile questioning whether short sellers seek information about and trade shares of such firms more actively during the eventful period. A related question is whether short interest is high in firms with a low level of transparency in general due to a lack of media coverage and a low level of voluntary disclosure, including a lack of managerial earnings guidance.

3.3. Short Sellers' Information Superiority and the Effect of Information Distribution on Equity Markets

3.3.1. Short sellers' information superiority vis-à-vis other parties

While financial analysts are among the most extensively researched information intermediaries, the relative advantage of short sellers in information processing and dissemination compared with financial analysts also attracts research interest. Studying US-

listed Chinese firms' financial reporting quality, Chen (2016) finds that short sellers tend to target firms with 'red flags', although analysts fail to uncover such risks. The firms that short sellers target experience significant negative abnormal returns, and this negative effect of stock returns even spills over onto the untargeted firms that share the same non-Big 4 auditors with the target firms and have poor earnings quality.

Cassell, Drake, and Rasmussen (2011) find a positive relationship between short interest (an indication of audit risks) and audit fees. This is consistent with short sellers' ability to identify firms with suspect financial reporting, an ability that sends a reliable signal about the increased risk of future misstatements. Importantly, the authors acknowledge that the two parties could rely on one another: auditors on short sellers, because the latter can detect misconduct, and short sellers on auditors, because auditors have access to clients' private information. The empirical evidence supports auditors' reliance on short sellers but not vice versa. Kecskes, Mansi, and Zhang (2013) find that debt holders respond to firms' level of, as well as changes in, short interest. In particular, firms with highly shorted stocks experience significantly lower credit ratings and are more likely to have their ratings downgraded.

Although the evidence above suggests the information superiority of short sellers to other information intermediaries, such information superiority does not guarantee short-selling profit. Recent reports and empirical evidence highlight that many short sellers make losses.²² For example, Gargano, Sotes-Paladino, and Verwijmere (2019) document that, for the average stock, 53 percent of the shares on loan experience losses. For the aggregate short-selling setting, the authors reveal that the average share shorted of a stock incurs a loss of about 10.5 percent. The authors also find that the tendency to reduce short interest increases monotonically with the size of the losses and that short sellers who incur losses are less informed about future

22. In a *Wall Street Journal* article, Zweig (2018) reports that, over the nine years before 2018, short funds lost more than 90 percent of their money.

returns than those who make gains. Jank and Smajlbegovic (2017) use data on daily disclosures in Europe to identify large short positions of individual institutions and study their performance. They provide evidence on short-selling skills among hedge funds, which earn annualized risk-adjusted returns of about 5.5 percent. It is possible to explain this performance with hedge funds trading on well-known factors (e.g. betting against beta) associated with mispricing. Of course, because the portfolios of short sellers typically have negative exposure to the market and other priced factors, an average loss in a bull market period can very well correspond to outperformance.²³

3.3.2. Information dissemination by short sellers and its effect on equity markets

While short sellers are well informed, it does not necessarily imply that their trading incorporates the superior information into prices, because some informed traders tend to trade in a way that restricts information dissemination (Boehmer & Wu, 2013). Therefore, many studies set out to investigate whether stock prices are more accurate when short selling is active. The general findings of these studies confirm that short selling speeds up the incorporation of public information into share prices and helps markets to correct short-term deviations of stock prices from the fundamental value and stock overvaluation (e.g. Chang, Luo, & Ren, 2014; Jones & Lamont, 2002).²⁴ Using high-frequency daily data on short selling, Boehmer and Wu (2013) find that the shorting flow indeed makes prices more efficient and that this process begins at intraday horizons.²⁵ Studying short-selling data from 46 countries, Bris et al. (2007)

23. We are grateful to an anonymous reviewer for drawing our attention to this strand of the short-selling literature.

24. Although most empirical studies on short selling suggest that short sellers short overvalued stocks because they are well informed, a few studies find that arbitrage needs motivate short selling rather than only exploiting the gain by shorting overvalued stocks. For instance, Liu and Wu (2014) find no abnormal short selling in stock acquirers ahead of a business merger announcement, indicating that short sellers are not informed about upcoming mergers. Their evidence also shows that merger arbitrage needs mainly motivate the increased short selling occurring on announcements of stock mergers and that the arbitrage price pressure that short selling generates contributes to the observed negative returns to stock acquirers around merger announcements.

25. However, Bergsma and Tayal (2019) provide evidence on short interest-related mispricing—overpricing (underpricing) in high (low) short-interest stocks. They find that the lottery stocks with a greater proportion of

find evidence that prices incorporate negative information more quickly in countries that permit and practice short sales, whereas, in markets that prohibit short selling or in which it is not feasible, market returns exhibit significantly less negative skewness. Lasser, Wang, and Zhang (2010) find that market reactions to earnings announcements vary with the level of short interest: that is, when extremely good news is released, firms with high levels of short interest tend to have higher abnormal returns around earnings announcements than firms with low levels of short interest. In contrast, in the case of extremely bad news in earnings announcements, firms with high short interest experience smaller abnormal returns relative to firms with low short interest.

Stock prices sometimes crash in response to bad earnings news exhibiting large negative skewness. When earnings miss analyst forecasts, even by small amounts, the negative earnings news can cause a disproportionately large stock price decline—the so-called torpedo effect (Skinner & Sloan, 2002). Whether short selling is responsible for the torpedo effect is contentious. On the one hand, research argues that short sales cause a torpedo effect, because short selling is immediate bad news and results in a price plunge (Aitken et al., 1998); on the other hand, Miller (1977) contends that stock will be overpriced if investors disagree about its value and the market constrains pessimistic investors from shorting it. In line with this theoretical argument, if short sellers, as rational arbitrageurs, are allowed to short overpriced stocks before the earnings announcement, they can offset the overpricing that overoptimistic investors cause. As a result, the price reaction to good and bad earnings news will be entirely symmetrical, effectively curbing the torpedo effect (Mashruwala & Mashruwala, 2014). Mashruwala and Mashruwala (2014) demonstrate consistent evidence that short-selling constraints, combined with investor disagreement, contribute to the torpedo effect. This is

unsophisticated retail traders have a higher arbitrage risk. The high risk results in costly arbitrage, so overvalued (undervalued) stocks exhibit more negative (positive) alphas.

consistent with short selling signaling immediate bad news, resulting in a price plunge (Aitken et al., 1998).

A large short volume also ameliorates post-earnings announcement drift (PEAD) (e.g. (Boehmer & Wu, 2013; Fang, Huang, & Karpoff, 2016), which is most pronounced during the month immediately following the earnings announcement (Boehmer & Wu, 2013). This is because short sellers accelerate the incorporation of earnings news into share prices (Berkman & McKenzie, 2012; Boehmer, Jones, & Zhang, 2013). Studies on short selling's role in PEAD further support the positive role of short sellers in promoting efficient pricing. Despite short sales' effect on mitigating PEAD, whether short sellers take short positions pre- or post-earnings announcements is an unreconciled research issue: although Berkman and McKenzie (2012) and Boehmer and Wu (2013) find reduced PEAD as a result of short sellers taking short positions immediately after earnings announcements, Christophe et al. (2004) demonstrate an increased short position pre-earnings announcements.

The informational benefits of short selling far exceed price discovery and stock valuation. Huszár, Tan, and Zhang (2017) report that short sellers profit more in complex industries with the highest profit potential. The results suggest that the aggregate shorted value at the industry level is able to predict important industry shifts, such as declines in sales and increased competition. Using cross-country data, Daouk, Lee, and Ng (2006) develop a composite governance index, including the relaxation of short-selling restrictions. They find that the index is associated with increased stock liquidity, a decreased cost of capital in the global market, reduced price synchronicity, and IPO underpricing. Beber and Pagano (2013) study the short-selling bans that 30 countries imposed (mostly European markets and developed non-European markets) during the period of the global financial crisis from January 1, 2008 to June 23, 2009. They find that bans on short selling slowed down efficient price

discovery.²⁶ Frino, Lecce, and Lepone (2011) provide similar findings of the negative impact of short-selling bans on 14 equity markets, evidenced by wider bid–ask spreads, increased price volatility, and reduced trading activity. Meanwhile, a few papers find that short-selling constraints accentuate momentum (Hong, Lim, & Stein, 2000; Jegadeesh & Titman, 1993), market crashes (Hong & Stein, 2003), accruals anomaly (Hirshleifer, Teoh, & Yu, 2011), and idiosyncratic risk (Stambaugh, Yu, & Yuan, 2015). In contrast, lifting the short-selling ban in China resulted in firms experiencing a lower cost of equity, conducting less earnings management, and enjoying higher market liquidity and higher investment efficiency (Hu, Lu, Ma, & Ye, 2019), while the removal of the short-selling ban for IPO stocks in Taiwan increased price efficiency (Cheng et al., 2012).

Short sales' information function is salient in a market with high investor sentiment. High investor sentiment causes investors and even financial analysts to be overly optimistic, thereby discouraging analysts from gathering and processing public information to produce private information (Keshk & Wang, 2018). In this situation, high short interest in certain stocks sends a negative signal that contradicts the overly optimistic belief, a red flag about future performance. Receiving such a signal motivates financial analysts to exert more effort on collecting information to produce more reliable forecasts. Keshk and Wang (2018) find evidence supporting this prediction. The findings show how other information users benchmark their beliefs according to short sellers' activities, shedding light on the signaling effect of short sales. An intriguing question for future research is whether financial analysts, institutional investors, and other investors in general benchmark their trading strategies according to short sellers' trading activities.

26. However, Kolasinski, Reed, and Thornock (2013) report that, during the 2008 short-selling ban period in the US, short-selling activity became more informative. Beber and Pagano (2013, pp. 347–348) nevertheless reconciled this contradictory evidence by noting the following, 'in the presence of a partial short-selling ban, banned stocks may feature slower price discovery ... yet their price may become more sensitive to the short sales that investors are allowed to carry out on other stocks—especially if the ban is accompanied by increased disclosure of short sales, as indeed was the case in the United States during the crisis.'

Section summary. Short sellers are collectively informed; they predict corporate negative news and front run analysts' recommendations and insider trading; they possess superior information to financial analysts; and they trade on firm-specific information pre-earnings announcements. As a result, short sellers' trading provides capital markets with discernible benefits.

4. Short Selling, Corporate Decisions and the Third-Party Effect

Do secondary stock markets have a real effect on corporate decision making or do they merely reflect the market expectations of firm values (see Goldstein & Guembel, 2008)? In the following sections, we review the stream of literature that examines the effects of short-selling activities (a financial market mechanism) on corporate real decisions (section 4.1), on financial reporting decisions (section 4.2), and on external auditing (section 4.3).

4.1. Short Selling and Real Economic Decisions

The extant studies, as demonstrated in Table A2 (see online appendices), provide evidence that short-selling constraints, and the removal of these constraints, alter a firm's investment activities, financing decisions, payouts, and other corporate policies. Using Reg SHO as a setting, Grullon et al. (2015) show that an increase in short-selling activity lowers share prices, which in turn reduces investment and equity issues. Importantly, this finding is stronger for small-growth and opaque firms that are susceptible to overvaluation. However, what is unclear is whether the resulting changes in investment behavior have a bearing on future firm performance. Chang, Lin, and Ma (2019) explore how the short-selling threat affects mergers and acquisitions (M&A) returns. They argue that short sellers scrutinize managers' future actions and thus make them less likely to waste corporate resources on empire-building activities. Furthermore, since short sellers' own capital is at stake, they have a greater incentive

to undertake in-depth investigations into M&A deals. The results demonstrate that short-selling threats result in higher M&A announcement returns. However, the governance role of short selling in improving M&A efficiency is only observable for deals that are prone to agency problems (e.g. when acquirers are financially less constrained).

With respect to the implications of short selling for payout decisions, Chen et al. (2019) provide causal evidence that managers increase cash dividends (but not stock repurchases) as a reaction to the removal of the short-selling constraint that Reg SHO implemented. This is because paying a dividend is costly and thereby serves as a credible signal of stock undervaluation that deters short sellers from shorting such stocks. Meanwhile, de Jong, Dutordoir, and Verwijmeren (2011) find evidence that firms issuing convertible notes simultaneously buy back their stocks to facilitate short selling by convertible debt arbitrageurs in an effort to mitigate the negative stock price reaction at the convertible debt issuance. Meng, Li, Chan, and Gao (2020) show that short sellers' ability to uncover and disseminate a firm's negative information to the market makes access to external financing difficult and costly. This might explain the positive relationship between short-selling threats and corporate cash holdings (Wang, 2018). However, it is not clear whether investors value such high cash holdings. Future studies may shed light on this unresolved question. Finally, Guo, Chi, and Cook (2018) find that firms engage less in corporate tax avoidance strategies when the short-interest levels are high. High tax avoidance is likely to signal bad news and might prompt short sellers to take a short position in such firms. Consequently, short selling could discipline aggressive tax-planning strategies. However, tax avoidance could also be beneficial for shareholders, because it conserves cash (Edwards, Schwab, & Shevlin, 2016). The authors do not include this relevant cost–benefit trade-off proposition in their empirical specification.

Prior studies also provide evidence on the governance role of short sellers. For example, DeAngelis et al. (2017) exploit the Reg SHO regime to investigate managerial incentive

contract design. They demonstrate that firms with increased short-selling pressure are likely to grant relatively more stock options to top executives and adopt new anti-takeover provisions. They argue that, in the presence of short-selling interest, the share price becomes more informative about the agent's effort and so can align better with pay-for-performance measures. An increase in anti-takeover provisions in the compensation contract post-Reg SHO is due to bear raiders depressing stock prices, a phenomenon that presents career concerns for managers. Anti-takeover provisions often reduce such concerns by providing managers with greater job security (Edmans, Goldstein, & Jiang, 2012). Bennett and Wang (2018) and Kunzmann and Meier (2018) show that short selling increases the likelihood of forced CEO turnover, either through the revelation of negative information or through the manipulation of stock prices. However, the extent to which CEO power moderates this documented relationship is unexplored. Finally, He and Tian (2015) posit that short sellers play a disciplining role and thus help to improve the inherent quality and fundamental nature of corporate innovation, resulting in improved innovation efficiency. As expected, they find that the short-selling pressure that Russell 3000 index pilot firms experienced as a result of Reg SHO indeed improved corporate innovation efficiency, a long-term outcome.

4.2. Short Selling and Firms' Financial Reporting Decisions

4.2.1. Short selling and earnings quality

The financial reporting system is an important mechanism to improve capital allocation efficiency. Financial reporting offers capital providers the primary source of independently verified information about the performance of managers (Sloan, 2001), thereby facilitating efficient resource allocation decisions by signaling investment opportunities to managers and outside investors, disciplining self-interested managers to invest in value-maximizing projects, and reducing firms' cost of capital (Bushman & Smith, 2001). It is therefore not surprising to

see a surge in research, as shown in Table A3 (see online appendices), on the effect of short-selling activities on various aspects of firms' financial reporting quality.

Drake, Myers, Myers, and Stuart (2015) document that short sellers improve the informativeness of stock prices with respect to future earnings. As short sellers are likely to take a short position in firms for which stock prices have yet to incorporate information about future fundamentals, the authors posit that short interest will facilitate the incorporation of future earnings news into current stock prices. They find evidence in support of this hypothesis. Furthermore, they find that this positive association is stronger in firms with a weaker information environment, high valuation uncertainty, and high expected future earnings growth.

In addition to using the market perception of earnings as a proxy for earnings quality, research investigates the effect of short-selling activity on accruals and real earnings management. Using firm-level short-selling data from 33 countries over a sample period from 2002 to 2009, Massa et al. (2015) document a significantly negative relationship between the threat of short selling and accruals earnings management (AEM). The evidence is consistent with the disciplining hypothesis, which predicts a decrease in earnings manipulation as short sellers are sophisticated traders who are skilled at uncovering managerial misconduct. Massa et al. (2015) establish causality running from short-selling threats to earnings management using instrumental variable tests and exogenous regulatory shocks related to short-selling threats. Jiang, Qin, and Bai (2020) extend Massa et al.'s (2015) research by revealing that a short-selling threat constrains real earnings management (REM) internationally, a finding that is primarily driven by firms operating in countries with weak shareholder protection. Furthermore, firms with great short-selling potential substitute AEM with REM. Moreover, they find that the monitoring effect of short sales is more pronounced in countries where short sales are not only legal but also feasible.

In contrast to the study by Karpoff and Lou (2010), who investigate whether short sellers can anticipate restatements stemming from previous financial manipulation, Fang et al. (2016) document that Reg SHO pilot firms exhibited less earnings management during the pilot period than non-pilot firms. They conclude by noting that ‘the pilot program reduced the cost of short selling sufficiently among the pilot firms to increase potential short sellers’ monitoring activities, and that the increased monitoring induced a decrease in these firms’ earnings management’ (Fang et al., 2016, p. 1253). The authors also find that earnings persistence increased for pilot firms during the pilot period and PEAD disappeared for pilot firms only in the bottom decile with the most negative earnings news during the period, while it remained significant for non-pilot firms.

Jin, Lin, Yang, and Zhang (2018) find that the prospect of short selling significantly increases conditional accounting conservatism among firms that are eligible for short selling, using China’s short-selling pilot program as an experimental setting. The positive association is more pronounced for state-owned enterprises (SOEs), because short sellers are likely to exert more disciplining effects on SOEs as they generally suffer from poor performance and lower conservatism and are more prone to earnings manipulation. The authors further document a significant reduction in conservatism for firms removed from the short-selling eligibility list, thereby corroborating short sellers’ disciplining role. Young (2016), on the other hand, documents an adverse effect of reducing short-selling constraints in the US, revealing a reduction in conditional conservatism among the pilot firms compared with the non-pilot firms from the year before to the year after Reg SHO began.

4.2.2. Short selling and corporate disclosures

The empirical literature on the effect of short selling on disclosure behavior predominantly focuses on managerial earnings forecasts, because managerial earnings forecasts are an

important source of corporate financial information for investors and yet managers have considerable discretion about whether to issue forecasts, forecast formats, and precision (Hirst, Koonce, & Venkataraman, 2008). We summarize this stream of literature and report them with detailed information in Table A3 (see online appendices).

Li and Zhang (2015) use Reg SHO as a natural experiment to examine the causal effect of short-selling constraints on managers' voluntary disclosure choices. The authors predict that managers of pilot firms will reduce the precision of short-run bad-news forecasts to maintain the current level of stock prices, a prediction that they premise on the notion that the magnitude of the price reaction to a disclosure is positively related to its precision. Measuring forecast precision as the negative of forecast width, the authors reveal that the pilot firms indeed reduced their bad-news forecast precision by about 17 percent relative to the control group on the adoption of Reg SHO. They find no such evidence for changes in good-news forecast precision between the treatment and the control group. Li and Zhang (2015) also do not find any significant relationship between short-selling threats and bad-news forecast disclosures. They further find that managers of pilot firms with bad earnings news reduced the readability of their annual reports around the implementation of Reg SHO. Whether short sellers target firms with poor readability of financial statements, however, remains unclear. Nevertheless, Clinch, Li, and Zhang (2019) find that, relative to control firms, pilot firms increase the likelihood of voluntary bad-news management forecasts, provide these forecasts in a timelier manner, and accelerate the release of quarterly bad earnings news.²⁷

Chen, Cheng, Luo, and Yue (2019) extend the work of Li and Zhang (2015) by examining whether managers strategically enhance long-run forecasts to discourage short sellers, because holding the position for a long time is costly and risky for short sellers. Chen

27. Clinch et al. (2019) find that the inconsistent results are attributable to the inclusion of prior forecasting behavior as a control variable (p. 13), a variable that Li and Zhang (2015) do not include.

et al. (2019) predict that the pilot firms will increase good-news disclosures to mitigate the downward pressure on stock prices because of the increased short-selling threat, and they find evidence consistent with this hypothesis. The increase is more pronounced when managers' forecasts are of higher quality; when there is greater uncertainty regarding firm value; and when managers have higher equity incentives. Finally, the authors show that pilot firms issuing more long-run good-news forecasts during the pilot program experienced a smaller increase in short interest. While Li and Zhang's (2015) findings suggest that short sellers may indirectly lead to a worsening of the information environment, Chen et al. (2019) find that managers' strategic disclosure response to a short-selling threat can improve the information environment quality. However, it is notable that Chen et al. (2019) use *annual* management forecasts, whereas Clinch et al. (2019) and Li and Zhang (2015) use *quarterly* management forecasts; therefore, a direct comparison among these studies may not be appropriate. Kubick, Omer, and Song (2019) find that firms improve their tax disclosures when the threat of short selling increases to minimize the possibility of a subsequent stock price drop. They find that this effect is stronger among pilot firms led by senior executives whose stock and option portfolio is more sensitive to changes in the stock price.

4.2.3. Short selling and external auditors

Short selling also affects firms' contracts with auditors. Hope, Hu, and Zhao (2017) examine the effects of short-selling threats on audit fees and predict a positive relationship, arguing that higher ex-ante threats of short-selling activities lead to the auditors facing higher litigation risk, a precursor for an increase in audit fees. Using the Reg SHO setting, they find that the pilot firms experienced a larger increase in audit fees than the non-pilot firms. Further empirical analyses confirm that the positive effect is attributable to a shifting risk premium instead of increased audit efforts, as they find no evidence that short-selling threats increase the audit

quality (a proxy for audit efforts). Given the existing evidence that short-selling threats improve the financial reporting quality (Fang et al., 2016; Massa et al., 2015), the insignificant findings that Hope et al. (2017) report stand as a contrast to the prior literature. Table A3 (see online appendices) includes a few papers pertinent to this topic.

Section summary. This section summarizes the strand of literature that investigates the effects of short-selling activities on firms' real economic decisions and financial reporting properties. The accumulated evidence so far suggests that short-selling threats have profound implications for the efficiency and originality of corporate innovation, managerial empire-building incentives, executive compensation designs, and financial reporting quality. However, these two strands of literature have evolved rather independently, despite evidence suggesting that good-quality financial reporting acts as a conduit for more informative firm-level economic decisions (Roychowdhury, Shroff, & Verdi, 2019). Future research incorporating the interactions among short-selling threats, financial reporting quality, and economic decisions would provide useful insights into whether short sellers provide incremental benefits to capital market development.

5. Discussion and Future Research Agenda

In this section, we discuss several issues related to short selling that warrant future research, including potential research issues associated with the antecedents and consequences of short-selling activities.

5.1. Research on Motivations for Short Selling is in its Infancy

Despite considerable progress in the literature on short selling, our review suggests that much less attention is devoted to exploring the motives behind short selling. Therefore, we encourage more studies to fill this void in the literature. In particular, future research could explore

whether and how the firm-level corporate governance landscape motivates short sellers to take short positions. We make this proposition because Jensen (2005) asserts that the solution to problems stemming from overvalued equities rests with the board of directors and with the other elements of governance systems. Hence, it is worth inquiring whether sound governance systems deter short selling given short sellers' preference for shorting mispriced stocks. Potential areas to investigate might include the strength of internal control, managerial competence (e.g. managerial ability), the top management turnover, the existence of problem director(s), the breach of law/contingent liability, problematic corporate strategies, and other indicators of corporate long-term operational red flags. External parties may not perceive these issues clearly, but they may have an important bearing on the decline of stock prices in the future. Although a few studies use corporate governance as a possible moderator in their investigation of the effect of short selling on various outcomes (e.g. Callen & Fang, 2015), a direct investigation of how short sellers perceive and make use of their information advantage in relation to the corporate governance strength of the target firm is absent. We call on researchers to consider some salient governance mechanisms in future investigations.

Meanwhile, with the increasing awareness of sustainability and corporate social responsibility, whether short sellers also evaluate firms' CSR issues and perceive the hidden operational risks in this area is an unexplored research issue. An interesting avenue for future research would be to consider whether firms conduct impression management or provide a more credible signal through their engagement in CSR practices in the presence of short-selling interest. Hou, Meng, Zhang, and Chan (2019), using data from China, find that a firm is more likely to engage in corporate philanthropic (CP) activities when there is a surge in short selling. Their evidence appears to support the impression management hypothesis, as they argue that, in the short run and in the presence of short-selling pressure, a firm might shift into CP activities to divert attention from the firm's negative information. However, their CP variable fails to

capture the much bigger dimension of CSR activities (e.g. improvement in the workforce environment), thereby warranting future research. Similarly, Brockman, Luo, and Xu (2019) find that Reg SHO pilot firms significantly improved their employee relations in response to an increased threat of short selling. The authors further document that such firms experienced improved stock performance during the post-Reg SHO period after improving the workforce environment.

5.2. Endogeneity and Attempted Solutions

The endogeneity threat is massive in the short-selling literature. For example, endogeneity due to reverse causation is a serious concern in studies examining the relationship between financial reporting quality (FRQ) and short selling. On the one hand, a stream of literature finds that short sellers often target firms exhibiting poor FRQ; hence, those studies indicate FRQ as the predecessor of short selling. On the other hand, the literature demonstrates that a short-selling threat has profound implications for FRQ. Endogeneity pertinent to self-selection bias occurs if short sellers choose firms with poor FRQ to short in the first place, which results in the subsequent disciplining effect of short sellers that the studies observe. We note a stark contrast whereby Jain et al. (2019) and Jin et al. (2018), respectively, identify the same FRQ proxy as a determinant and a consequence of short selling. While Jain et al. (2019) demonstrate that short sellers are less interested in shorting stocks of firms with more reporting conservatism, Jin et al. (2018) find that short-selling threats prompt firms to report more conservatively, using China's short-selling pilot program as an experimental setting.

Reverse causality also confounds the relationship between short selling and stock price crash risk, as shown in the contradictory results that some studies provide. For example, Callen and Fang (2015) document an increase in price crash risk, while Deng, Gao, and Kim (2020)

find that the removal of short-sale constraints during Reg SHO led to a significant decrease in price crash risk.

To overcome this potential endogeneity problem, Deng et al. (2020) and Fang et al. (2016) conduct a quasi-natural experiment with the DiD test on pilot firms during Reg SHO as the treatment sample, while Massa et al. (2015) employ an instrumental variable approach along with a similar DiD test using US and Hong Kong sub-samples. Although these tests alleviate the endogeneity concern, a puzzling question is whether firms with a history of poor FRQ attract short sellers in the first place and then the short selling disciplines their future financial reporting activities at a later stage. To answer questions of this kind, a well-designed study can utilize specific events such as financial restatement announcements and fraud revelations to examine the ensuing (increase in) short interest and subsequent improvement in FRQ as a result of the spike in short interest. Cheng et al.'s (2019) recent study advances the methodology in this direction. It documents that, on the one hand, short sellers are attracted to firms with less comparative accounting information; on the other hand, they motivate firms to enhance future accounting comparability.

Meanwhile, although it is possible to use a two-stage instrumental approach, the selection of an appropriate instrumental variable raises enormous challenges. Research often uses financial institutional ownership as a proxy for the ease of short arbitrage (e.g. Hirshleifer et al., 2011). However, this approach is questionable and may not be valid in many cases, because institutional shareholding is often significantly associated with the dependent variable—for example financial reporting quality—due to its monitoring function. Hence, the literature (e.g. Massa et al., 2015) introduces an alternative instrumental variable, the ownership of exchange-traded funds (ETFs). ETFs also supply lendable shares to the short-selling market and are unlikely to become active monitors of the firms as passive investors, thereby upholding a low-fee trading strategy (Massa et al., 2015). However, the majority of

short-selling studies do not yet employ ETFs as an instrument, perhaps due to the lack of access to the data. Instead, many short-selling consequence studies conduct DiD tests using the US, China, or Hong Kong as their context, because short sales have experienced regulatory changes in these equity markets. The benefit of DiD tests is apparent, as the regulations simulate a natural experiment that frees the tests from the endogeneity concern. Nevertheless, this approach is restricted to markets that have enforced short-selling regulations over the selected sample period, which explains the lack of short-selling research using other equity markets.

Furthermore, refining the proxies for short-selling measures may provide a potential solution to the problem of reverse causality. For example, Cheng et al. (2019) regress the residual short-selling interest on contemporaneous accounting comparability and then regress the lead accounting comparability on the ex-ante short-selling pressure measure.

5.3. Information Black-Box Issues

The research on short selling over the last 50 years provides considerable knowledge. We have seen research on short sellers' use of both public information and private information and learnt that short sellers not only conduct independent research using fundamental analysis of financials but also receive tips from insiders and financial analysts so that they front run those parties by taking a short position before the negative information event (Christophe et al., 2010). However, from a broad perspective, whether and how short sellers analyze firms' business strategies, operational risks, supply chain stability, and prospects of M&A are unknown. For instance, in addition to the information tips from insiders and analysts, do short sellers have superior access to other information? How do they collect the private information that they use to facilitate their stock analysis? Alternatively, is it possible that short sellers run different prediction models from analysts and news reporters or are they simply quicker and more effective at processing and interpreting information than other investors? All in all,

elucidating the source of short sellers' information advantage is a meaningful avenue for future research.

While many studies adopt a piecemeal approach to proving short sellers' acquisition of a specific type of information, such as credit rating downgrades (Shi et al., 2017) and asset write-downs (Liu et al., 2012), they do not address the pecking order and the weighting of the information that short sellers use. Research has yet to explore which types of information are of greater importance and whether short sellers use a shotgun approach to identifying potential targets or a more holistic and analytical approach based on broad information sets.

In addition, an interesting line of further research is to investigate whether short sellers' information advantage and informed arbitrage was stronger prior to the Regulation FD that the SEC promulgated than after the regulation. Since Regulation FD prohibits private information communication between firms and market participants, research reports that public information is becoming the main source of firm-specific information post-Regulation FD (Heflin, Kross, & Suk, 2016). This restriction of private information communication between firms and other investors could provide stronger incentives for short sellers' private information seeking because of the potential arbitrage gain against other relatively uninformed investors, although Regulation FD may also restrict the possibility of short sellers gaining tips from other information sources when their sources have disappeared. Among the studies reviewed, that by Henry et al. (2015) is the only one making strides in this direction, finding an increase in the abnormal short interest prior to a bond rating downgrade, which is stronger after Regulation FD, indicating short sellers' information advantage.

5.4. Are Short Sellers Homogeneous?

The other area that we identify as being under-researched concerns different types of short sellers and their trading activities. For example, we cannot identify many studies that provide

evidence on the various categories of short sellers (e.g. informed versus manipulative and predatory short sellers) or determine whether a specific type of short seller results in less informative stock prices (Goldstein & Guembel, 2008) or causes overshooting of prices (Brunnermeier & Pedersen, 2005). Comerton-Forde, Jones, and Putniņš (2016) document two distinct types of short sellers—those who provide liquidity and those who demand it. Liquidity-supplying short sellers trade when spreads are wide, whereas liquidity-demanding short sellers trade when there is a narrow spread and when the short-term price declines. Reed, Samadi, and Sokobin (2019) investigate how short sellers exploit their information advantage by trading at different trading venues, namely exchange versus dark pools. They find that, although all venue short sales are informative about future prices, exchange short sales are the most informative.²⁸ Chague, De-Losso, and Giovannetti (2019) differentiate skilled institutional and individual short sellers from unskilled ones. The authors find that skilled short sellers trade with short-term horizons and follow momentum strategies, whereas unskilled short sellers display the disposition effect, riding losses and realizing gains to cover a winning position quickly. We contend that different types of short seller following the arbitrage strategy may utilize different types of information (e.g. seeking information tips from other insiders) from those focusing on firms' fundamentals and conducting a thorough stock analysis. The specific information sets that different types of short seller use warrant further investigation.

Meanwhile, we also observe the need for more empirical cross-country studies. Many studies focus on a single country, including the US and China, and a few developed markets, including Australia (e.g. Comerton-Forde et al., 2016) and Hong Kong (Bai & Qin, 2014, 2015; Chang et al., 2007; Chen & Rhee, 2010). We also find a few cross-country studies that provided insights into short-selling regulations and institutional feasibility across countries (Bris et al.,

28. It is possible to submit exchange orders for immediate execution even if the execution prices fall outside the prevailing National Best Bid and Offer (NBBO). In contrast, dark pools are necessary to match orders at prices within the NBBO. Although this matching can reduce the bid–ask spread costs, if no match is available within the NBBO, then no trade takes place (Reed et al., 2019).

2007); the consequences of short-selling bans during the 2007–2009 global financial crisis (Beber & Pagano, 2013); and the disciplining functions of short-selling threats on financial reporting quality (Jiang et al., 2020; Massa et al., 2015). Given the difference in institutional factors, the extent of market efficiency, and investors' financial literacy worldwide, future research in the area of short selling could focus on the heterogeneities of short sellers and institutional settings to examine some of the issues that the short-selling literature investigates to enrich our understanding.

Given the information roles and the disciplinary functions of short selling that the literature reveals, many studies uphold an anti-regulation proposition and advocate the removal of short-selling constraints (Diether et al., 2009a). However, the regulators appear to be much more cautious in supporting such an anti-regulation perspective. These contrasting views raise an important research question—whether and how much the academic short-selling literature has informed regulators and, if not, what obstacles prevent regulators from adopting a more liberal approach regarding short-selling regulation. International studies would best answer these questions, investigating the variation in institutional factors such as the strength of shareholder protection and the maturity of the stock markets to provide potential answers.

6. Conclusion

The goal of this literature survey is to summarize and highlight the advances in the research areas pertinent to short selling. A key theme in our survey is that short sellers conduct intensive information collection using both public and private information to facilitate their trading decisions and that this has fundamentally shaped information dissemination, stock price discovery, and managerial decision making. We follow this theme to select papers for the survey and highlight areas requiring additional research to further our understanding of short sellers' role in capital market development.

The first part of the review reveals the controversies in the short-selling literature by demonstrating contradictory findings and the evolving nature of the regulations worldwide. To facilitate the understanding of the empirical literature that the later sections cover, section 2 also provides a critical discussion of the commonly used short-selling measurements. Because of our focus on short sellers' information collection and sharing, we organize a large volume of literature concerning the information roles of short selling into three sub-sections to demonstrate short sellers' information sources, the firm characteristics of the targeted stocks, and the information roles of short selling in the equity markets. Section 4 analyzes and points out the evolving nature of the short-selling literature, demonstrating a focus on the managerial actions taken as a response to short-selling threats. This new stream of literature shows an intersection between short selling and corporate decision making.

Our major observation of the literature indicates that, although many papers appear in finance journals, there is also a sizeable number of accounting papers on short sellers' information collection and the interplay between short selling and corporate decisions, especially corporate disclosure choices. A critical summary of the literature highlights a few limitations of the current research, including the lack of studies focusing on the motivations for short selling; the insufficient insight into whether short sellers obtain private information, how, and of what type; and the endogeneity concerns confounding the causal relationships between short selling and various outcome variables. We also call for research in an international setting, because it potentially offers richer insights into the interplay between institutional factors and short selling.

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TABLE A1. Summary of research on short sellers' information production and the securities that short sellers target

Author(s)/year	Research issue(s)	Sample	Findings
Ackert and Athanassakos (2005)	Short interest and stock returns.	Canada: sample periods: 1991–1994 and 1998–1999; sample size: 72,021 observations for 1789 firms.	Short sales and excess returns are negatively correlated in Canada. In addition, this negative relation is more pronounced for small firms but less pronounced for shorted stocks with options and convertibles. The evidence suggests that less restrictive regulation of short sales improves market efficiency.
Aitken, Frino, McCorry, and Swan (1998)	Market reaction to short sales.	Australia: sample period: 1994–1996; sample size: 4,773 and 10,548 observations pertaining to market orders and limit orders, respectively.	Short selling is related to significantly negative abnormal stock returns in a market setting in which short sales are transparent immediately following execution. Furthermore, short sales executed near the end of the financial year and those related to arbitrage and hedging activities are associated with a smaller price reaction. However, short sales near information events are related to larger price reactions.
Akbas, Boehmer, and Erturk (2017)	Short selling, stock returns, and unfavorable information.	US: the test for short interest and future returns covers the period 1998–2010, while the test for short interest and future public news covers 267,971 stock-month observations spanning the period 2000 to 2010.	Short selling is related to future negative earnings surprises, bad public news, and downgrades in analyst earnings forecasts. The information role of short selling is stronger for stocks that are harder to short. Short interest increases gradually during the 12 months immediately preceding the public release of negative information but then declines. The results suggest that short interest predicts future returns, partly due to short sellers' ability to uncover unfavorable information about firms.
Anderson, Reeb, and Zhao (2012)	Organization structure and the information content of short sales.	US: 1,571 firms covering the period from January 2005 through July 2007.	Family-controlled firms experience substantially higher abnormal short sales prior to negative earnings shocks than nonfamily firms. Moreover, daily short-sale interest in family firms contains useful information for forecasting stock returns. Overall, the findings suggest that informed trading via short sales occurs more readily in family firms than in nonfamily firms.
Andrikopoulos, Clunie, and Siganos (2012)	Short selling and firm performance.	UK: weekly short-selling activity in 1,645 UK firms between 2004 and 2012.	High short-selling firms tend to underperform their low short-selling counterparts <i>weakly</i> . However, UK short sellers tend to predict firms' performance successfully during the financial crisis, particularly for bankrupt firms. After excluding those firms, arbitrage portfolio returns disappear, revealing that short sellers' ability to predict firm performance is driven by a small number of struggling firms.

Author(s)/year	Research issue(s)	Sample	Findings
Asquith, Pathak, and Ritter (2005)	Short interest, institutional ownership, and stock returns.	US: a sample of NYSE and Amex stocks from 1980 to 2002 and Nasdaq National Market System (NMS) stocks from July 1988 to December 2002.	Portfolios of stocks with high short interest underperform the market. When short interest portfolios are ranked by institutional ownership, more negative portfolio abnormal returns are observed for portfolios with lower institutional ownership.
Au, Doukas, and Onayev (2009)	Short selling, idiosyncratic risk, and stock returns.	UK: a sample of daily FTSE 350 stock-lending data from September 2003 through September 2006.	Using daily UK short-selling data, the authors find that stocks with low levels of short interest experience significant positive abnormal returns on a value-weighted basis: equally weighted portfolios composed of highly shorted stocks exhibit positive but statistically insignificant abnormal performance. The authors further document a negative relation between short interest and returns among stocks with high idiosyncratic risk and show that short-selling activity is mostly concentrated in stocks with low idiosyncratic risk, which are less costly to arbitrage with respect to those with fundamental risk.
Bai and Qin (2014)	Impact of short-sale constraints on liquidity for individual stocks.	Hong Kong: 1364 constraint-repealing and 845 constraint-imposing events.	Following the repealing of short-sale constraints, only large, illiquid, and inactively traded firms increase in liquidity, while other firms experience a significant drop in prices and liquidity. When short-sale constraints are imposed, only inactively traded stocks significantly increase in liquidity and prices.
Bai and Qin (2015)	Short-sale constraints and stock price adjustments to	Hong Kong: the sample covers the period between January 1, 1994 and December 31, 2011.	Shortable stocks adjust to private bad information more quickly than non-shortable stocks. In addition, although non-shortable stocks are overpriced before negative earnings announcements, these stocks react more strongly to the publication of bad information than shortable stocks. Overall, the
Bao, Kim, Mian, and Su (2019)	Residual short interest and managerial tendency to disclose or withhold bad news.	US: 152,614 firm-quarter observations between 2001 and 2010.	Residual short interest is negatively associated with the frequency of bad-news disclosure, implying that managers, in general, withhold bad news. This documented negative relation is weaker when firms are exposed to higher litigation risk but stronger when managers have greater incentives to inflate the stock price.

Author(s)/year	Research issue(s)	Sample	Findings
Beber and Pagano (2013)	Effect of worldwide short-selling bans on liquidity, price discovery, and stock prices.	Global data: the sample consists of daily data for 16,491 stocks in 30 countries, from January 2008 to June 2009.	Imposing bans or regulatory constraints on short selling (i) is detrimental to liquidity (e.g., an increase in bid–ask spreads), especially for stocks with small capitalization and no listed options; (ii) slows price discovery, especially in bear markets, and (iii) is not associated with better stock price performance, the only exception being the US.
Beneish, Lee, and Nichols (2015)	Economic determinants and stock price consequences of the level of short-sale supply.	US: 299,535 firm-month observations spanning 114 months (July 2004–December 2013).	The lendable supply increases with expected borrowing costs and decreases with firm characteristics associated with equity overvaluation. In addition, (1) when the lendable supply is binding (non-binding), the short-sale supply (demand) is the main predictor of future stock returns, (2) abnormal returns to the short side of nine well-known market anomalies are attributable solely to “special” stocks, and (3) loan fees significantly reduce the profitability of the short side and several of these anomalies cease to be profitable.
Bergsma and Tayal (2019)	How lottery-like characteristics are associated with high and low short-interest-related mispricing.	US: 479 (504) high (low) relative short-interest firms spanning from 1989 to 2015.	High relative short interest (RSI) stocks’ overvaluation and low RSI stocks’ undervaluation are the strongest among lottery stocks. As stocks become more lottery-like, the arbitrage risk increases, resulting in more overpricing (underpricing) in high (low) RSI stocks.
Berkman and McKenzie (2012)	Trading behavior of institutional investors and short sellers around earnings announcements.	US: 14,656 earnings announcements from 2,695 firms covering the period from August 2006 to May 2008.	Institutional investors and, to a lesser extent, short sellers successfully anticipate earnings news. In the period immediately after an earnings announcement, short sellers are quick to increase their short positions when a company releases bad news, while institutional traders react more slowly in the period following the announcement.
Berkman, McKenzie, and Verwijmeren (2016)	Trading behavior of short sellers around private placements.	US: 323 (339) convertible bond (common stock) issues by 536 unique firms for the period January 2007 to August 2011.	There is a significant increase in short interest in the pre-announcement period: evidence of information leakage. In addition, the change in short interest in the pre-announcement period is negatively related to the abnormal return at the time of the public announcement of the private placement. The pre-announcement short selling is particularly informative when the number of buyers is high and when there is a high degree of hedge fund participation.

Author(s)/year	Research issue(s)	Sample	Findings
Boehmer and Wu (2013)	Short selling and informational efficiency of stock prices.	US: The sample includes the daily average of 1,361 NYSE-listed common stocks from January 2005 to December 2007.	Short selling improves the intraday informational efficiency of stock prices by accelerating the incorporation of public information into prices. Moreover, a greater shorting flow reduces post-earnings announcement drift for negative earnings surprises. Finally, short sellers change their trading around extreme return events in a way that assists price discovery and reduces the divergence from fundamental values.
Boehmer, Jones, and Zhang (2008)	Informativeness of different types of short sales.	US: Daily average of 1,239 NYSE-listed common stocks between 2000 and 2004.	The authors report a large amount of shorting activity across both large and small NYSE stocks, suggesting that shorting constraints are not widespread. Heavily shorted stocks underperform lightly shorted stocks by a cumulative 1.16% on average on a risk-adjusted basis (15.6% annualized). Institutional nonprogram (program trade is defined as simultaneous orders to trade 15 or more securities with an aggregate total value of at least \$1 million) short sales are the most informative; stocks that are heavily shorted by institutions underperform by 1.43% in the next month (19.6% annualized).
Boehmer, Huszar, and Jordan (2010)	Absence of short selling and informativeness of future returns.	US: 930,109 stock-month observations from June 1988 to December 2005.	Portfolios of lightly shorted stocks have significant positive abnormal returns. These returns are often larger (in absolute values) than the negative returns on the portfolios of heavily shorted stocks.
Boehmer, Jones, and Zhang (2013)	Effect of a shorting ban on market quality, shorting activity, and stock prices.	US: 727 stocks in a sample from August 1 to October 31, 2008.	During the shorting ban, shorting activity dropped by an average of 77% in affected large-cap stocks. Although small-cap stocks were largely unaffected, large-cap stocks that were subject to the ban suffered a severe degradation of market quality, as measured by quoted and effective spreads, price impacts, and realized spreads.
Bris, Goetzmann, and Zhu (2007)	Short-sale restrictions and market efficiency.	Global data: 668 observations pertaining to a sample of 46 countries during the period 1990–2001.	To some extent, prices incorporate negative information faster in countries in which short sales are allowed and practiced. The lifting of short-sale restrictions is associated with increased <i>negative skewness</i> in market returns. However, short sales have no significant impact on the <i>frequency of crashes</i> . These two results imply that extreme returns become more negative but not more frequent.
Callen and Fang (2015)	Relationship between short interest and stock price crash risk.	US: 40,660 firm-year observations for the years 1981–2011.	Short interest is positively related to future stock price crash risk. This positive relationship is more pronounced for firms with weak governance mechanisms, excessive risk-taking behavior, and high information asymmetry between managers and shareholders.

Author(s)/year	Research issue(s)	Sample	Findings
Chague, De-Losso, and Giovannetti (2019)	Short-selling skill of institutions and individuals.	Brazil: 3,341,213 loan contracts involving 357 different stocks by 4,107 institutions and 35,338 individuals from 2012 to 2014.	Only 8.9% of <i>institutions</i> consistently profit from shorting; these are responsible for 31.5% of the total shorting volume and 26.7% of the total number of shorting deals. On the other hand, only 4.2% of <i>individuals</i> consistently profit from shorting, and they are responsible for 0.3% of the total shorting volume and 2.5% of the total number of shorting deals. Skilled short sellers follow short-term momentum strategies; they are more likely to pick value, liquid, short- and long-term losers, and high-volatility stocks; and they initiate a short position after price drops, prior to earnings announcements, and around sell recommendations.
Chakrabarty and Shkilko (2013)	Short-seller informedness about recently completed (or ongoing) insider sales.	US: an average of 820 short trades per day with an average daily short volume of 269,424 shares between May 2005 and December 2006.	A significant increase in short positions is observed on days when company insiders sell their firms' shares. Short selling increases before insider sales are publicly reported and often before insiders finish selling. Short sellers' superior timing is consistent with (i) monitoring the order flow and (ii) obtaining price-relevant information from brokerages that execute insider sales.
Chang, Cheng, and Yu (2007)	Short-sale constraints and stock overvaluation.	Hong Kong: 383 events clustered across 18 short-sale restriction change dates.	Short-sale constraints tend to cause stock overvaluation, and the overvaluation effect is more dramatic for individual stocks for which wider dispersion of investor opinions exists. When short sales are allowed, there is higher volatility and less positive skewness of individual stock returns.
Chang, Luo, and Ren (2014)	Effect of lifting the short-selling ban on price efficiency.	China: January 1, 2010 to December 31, 2012; 285 stock addition events.	Stocks experience negative returns when they are added to the short-selling list. After the lifting of the short-selling ban, the price efficiency increases while the stock return volatility decreases.
Chen (2016)	Informational role of short sellers for US-listed Chinese firms.	China: 1,314 (426) firm-year observations during the 2007–2014 period.	Short sellers tend to issue reports on firms that have financial reporting red flags and that exhibit good reported operating performance and high stock valuations. <i>Targeted</i> firms experience an average three-day cumulative abnormal return (CAR) of –6.4% and –13.6% for the initial coverage of the firm, whilst <i>nontargeted</i> firms suffer a negative spillover effect, especially when they hire the same non-Big 4 auditors as targeted firms.
Chen and Rhee (2010)	Speed of price adjustment to new information for stocks included in	Hong Kong: a total of 86 stocks for the period December 2001 to 2004.	Short sales contribute to market efficiency by increasing the speed of price adjustment not only to private/public firm-specific information but also to market-wide information. Shortable stocks are characterized by weaker trade continuity and stronger quote reversals and adjust more quickly to new information than their non-shortable counterparts.

Author(s)/year	Research issue(s)	Sample	Findings
	the shortable stock list.		
Chen, Kadapakkam, and Yang (2016)	Short selling and the incorporation of new information into prices.	China: the sample periods include the pre- and post-eligibility periods starting on January 1, 2007 and ending on March 31, 2014.	There is a positive association between the degree of information efficiency of stock prices and the intensity of short selling and margin trading. Short selling escalates during the 5 days immediately before significant negative information events, suggesting that short sellers anticipate forthcoming news.
Cheng, Yan, Zhao, and Chang (2012)	Short selling, IPO price efficiency, and the fundamental value of IPO stocks.	Taiwan: 139 IPOs on the TWSE between January 1, 1997 and December 31, 2005.	Price efficiency is improved with increased short selling after the lifting of short-sale constraints on IPO stocks; short sellers tend to target IPO stocks with low fundamental ratios but simultaneously avoid IPO stocks with high transaction costs.
Chi, Pincus, and Teoh (2014)	Mispricing of book–tax differences (TI/BI) and the trading behavior of short sellers.	US: sample period 1988 to 2009, with a total of 78,320 firm-year observations for the short-selling test.	TI/BI incrementally predicts future earnings growth and future abnormal stock returns. A TI/BI trading strategy earns an annualized return of approximately 9 percent, adjusted for standard risk characteristics: strong evidence of mispricing by the market. The authors(s) find that short interest decreases by an economically large 33 percent moving from the lowest to the highest quintile of TI/BI. Further evidence suggests that mispricing of TI/BI is not fully eliminated because short arbitrage is costly.
Choy and Zhang (2019)	Impact of short-sale restrictions on stock price efficiency when firms make public earnings announcements.	Hong Kong: a total of 9882 firm-announcement observations, with 6537 from short-prohibited firms, between 1 January 1994 and 31 December 2012.	Stocks that are prohibited from short selling experience significantly lower post-announcement returns for both positive and negative news shocks. The informational inefficiency due to short-sale restriction is particularly severe for firms that experience negative announcement period shocks and are subject to greater differences of opinion.

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Christensen, Drake, and Thornock (2014)	Pro forma earnings disclosures and short selling.	US: 1,908 quarterly earnings announcements containing adjusted earnings numbers over the 2005–2007 period.	Short selling is significantly high around earnings announcements containing pro forma earnings disclosures, a finding that suggests that short sellers view pro forma earnings disclosures as a strong signal of poor reporting quality or overvaluation. Additional analysis shows that short sellers are particularly active in shorting stocks of firms that exclude recurring items. Finally, the authors reveal that highly shorted stocks containing pro forma disclosures exhibit significantly more negative subsequent market-adjusted abnormal returns than those without pro forma disclosures.
Christophe, Ferri, and Angel (2004)	Short-selling transactions in the five days prior to earnings announcements.	US: 913 Nasdaq-listed firms for the period from September 13 to December 12, 2000.	Abnormal short selling is significantly linked to post-announcement stock returns. Short sellers are typically more active in growth stocks than in value stock or stocks with low standardized unexpected earnings, as those stocks provide better opportunities for substantial declines in price over time. The pre-earnings announcement short-selling activities appear to reflect firm-specific information rather than these fundamental financial characteristics.
Christophe, Ferri, and Hsieh (2010)	Short-selling activities prior to the release of analyst downgrades.	US: 670 downgrades of Nasdaq stocks between 2000 and 2001.	There are abnormal levels of short selling in the three days before the public announcement of downgrades. The pre-announcement abnormal short selling is significantly related to the subsequent share price reaction to the downgrades, especially for downgrades that prompt the most substantial price declines.
Comerton-Forde, Do, Gray, and Manton (2016)	Nature and source of information reflected in short-selling metrics, namely short flow and short interest.	Australia: 629 daily observations of stock-level short flow and short interest over the period spanning January 2012 to June 2014.	Short sellers are heterogeneous with respect to their information and investment horizon. The <i>short flow</i> is strongly related to recent returns and buy–order imbalance, anticipates imminent price-relevant announcements, and reacts to news, increasing (decreasing) following bad (good) earnings news. Short sellers target overpriced stocks and are adept at avoiding underpriced stocks. There is no evidence that the short flow is related to mispricing.
Comerton-Forde, Jones, and Putninš (2006)	Price discovery and liquidity provision by liquidity-supplying and liquidity-	US: short sales executed on the NYSE or Nasdaq from January 1, 2008 through August 31, 2008 for a sample of 350 stocks.	There are two very distinct types of short sales: those that provide liquidity and those that demand it. Liquidity-demanding short sales are likely to arise from informed traders, whereas liquidity-supplying short sales can arise when a market maker provides liquidity to an incoming buy order. Short sellers with a liquidity-supplying motive act when spreads are unusually wide, which is when market participants most highly value liquidity. They are also strongly contrarian: they initiate or increase a short position after

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	demanding short sellers.		fairly sharp share price rises over the past hour or so. Liquidity-demanding short sellers, on the other hand, are momentum traders, as their shorting activity tends to follow a price decline over the previous 24 hours.
Curtis and Fargher (2014)	Whether short selling amplifies price declines or aligns stocks with their fundamental values.	US: 576,640 firm-month observations over the period 1995–2011.	The increases in short interest for firms following a price decline are associated with measures of overpricing based on financial statement analysis. The finding supports the idea that the profitability of short selling following price declines is driven by valuation-based positions. Limiting short selling following price declines is likely to impede efficient price discovery.
Daouk, Lee, and Ng (2006)	Capital market governance and market performance.	Global: the sample period is from 1986 to 1998 for 32 countries with 4,375 firm year observations.	An improvement in the composite capital market governance (CMG) index (the degree of earnings opacity, the enforcement of insider laws, and the effect of <i>removing short-selling restrictions</i>) is associated with decreases in the cost-of-equity capital, increases in market liquidity, and increases in market pricing efficiency (IPO underpricing).
Dechow, Hutton, Meulbroek, and Sloan (2001)	Relationship between the trading strategies of short sellers and the ratios of fundamentals to market prices.	US: 24,913–33,724 firm-year observations. NYSE and AMEX firms in the years 1976–1993.	Short sellers position themselves in the stock of low ratios of fundamentals (such as earnings and book values) to market values that have systematically lower future stock returns. Short sellers refine their trading strategies to minimize their transaction costs and maximize their investment returns.
Desai, Ramesh, Thiagarajan, and Balachandran (2002)	Relationship between the level of short interest and the stock returns.	US: 329 to 2,726 sample observations of Nasdaq firms from June 1988 through December 1994.	Heavily shorted firms experience significant negative abnormal returns and are more likely to be delisted than their size, book-to-market, and momentum-matched control firms.
Desai, Krishnamurthy, and Venkataraman (2006)	Do short sellers target firms with poor earnings quality?	US: sample period from 1997 to 2002 with 477 restating firms with available data.	Short sellers accumulate positions in restating firms several months in advance of the restatement and subsequently reverse these positions after a restatement-induced share price drop. The increase in short interest is larger for firms with high levels of accruals prior to restatement. Furthermore, heavily shorted firms experience poor subsequent performance and a higher rate of delisting.

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Deshmukh, Gamble, and Howe (2017)	Short selling around seasoned equity offering (SEO) announcements.	US: sample period 1988 to 2011 with a final sample of 7129 equity offerings by 3584 firms.	Firms with large increases in short interest prior to the SEO announcement exhibit more negative announcement period returns, and firms with large increases in short interest around the SEO announcement experience inferior long-term operating and stock price performance following the equity issue. The results highlight the informational role of short sellers in identifying opportunistic market timers of equity issues.
Deshmukh, Gamble, and Howe (2015)	Short selling and operating performance.	US: sample period from 1988 to 2012 with 1,852,832 firm-month observations for 20,132 firms.	Firms in the top decile of increases in short interest experience a 21 percent subsequent decline in operating performance relative to matched control firms, a finding suggesting that short interest reflects private information about firm fundamentals rather than other factors that may drive stock price changes.
Diether, Lee, and Werner (2009a)	Effects of Reg SHO on stock markets.	US: NYSE- and Nasdaq-listed pilot stocks over the period from February 1, 2005 through July 31, 2005, with a total of 2,485 firms.	Short-selling activity increases for both the NYSE- and the Nasdaq-listed pilot stocks, but returns and volatility at the daily level are unaffected. NYSE-listed pilot stocks experience more symmetric trading patterns and a slight increase in spreads and intraday volatility after the implementation of the regulation, while there is a smaller effect on market quality for Nasdaq-listed pilot stocks.
Diether, Lee, and Werner (2009b)	Short sellers' trading strategies.	US: 1,481 (2,372) stocks on the NYSE (Nasdaq) market during the period January to December 2005.	Short sellers increase their trading following positive returns and correctly predict future negative abnormal returns. The results are consistent with short sellers trading on short-term overreactions to stock prices.
Drake, Myers, Scholz, and Sharp (2015)	Short selling around restatement announcements.	US: 2005–2007 sample period with 740 restatement announcements made by 648 unique companies.	The findings suggest that short sellers do not anticipate restatement announcement dates. However, Drake et al. (2015) find a significant increase in abnormal short selling when restatements are announced. The two findings taken together lead them to conclude that short sellers <i>respond to</i> , but <i>do not anticipate</i> , restatement announcements. Short sellers target small companies characterized by weaker information environments and companies making restatements that reduce the previously reported income. The restating companies that short sellers target most heavily experience the most negative subsequent abnormal returns.
Drake, Rees, and Swanson (2011)	Difference between short sellers and analysts in their	US: 80,674 firm-quarterly observations over the period 1994–2006.	Short interest is significantly associated, in the expected direction, with all 11 variables of stock valuation. In contrast, analysts tend to recommend positively stocks with high growth, high accruals, and low book-to-market ratios, despite these variables having a negative association with future

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	use of information to predict future returns.		returns. Short interest therefore appears to capture predictive information that investors can use in trading against analysts' recommendations to increase returns.
Duan, Hu, and McLean (2010)	Idiosyncratic risk and short selling	US: sample period 1988 to 2003.	High short-interest stocks generate low subsequent returns due to idiosyncratic risk (a proxy for costs limiting arbitrage). Among high short-interest stocks, a 1 standard deviation increase in idiosyncratic risk predicts more than a 1 percent decline in monthly returns but does not predict returns
Edwards and Hanley (2010)	Short selling in initial public offerings.	US: a total of 388 IPOs from January 1, 2005 through December 31, 2006.	Short selling occurs on the offer day in 99.5 percent of the IPOs in the sample, and the majority of first-day short sales occur at the opening of trading. The magnitude of short selling on the first trading day is positively and significantly related to variables that proxy for divergence of opinion: the change in offer price, the first-day return from the offer price to the open, and the initial trading volume. Short-selling and first-day returns are
Engelberg, Reed, and Ringgenberg (2018)	Short-selling risk and price efficiency.	US: approximately 220,000 observations at the firm-month level for 4,500 equities over the period 2006 to 2011.	Higher short-selling risk is associated with lower future returns, decreased price efficiency, and less short-selling activity by arbitrageurs. These effects are more pronounced for trades with a long expected holding horizon. In addition, short-selling risk is particularly high when there are extreme returns.
Engelberg, Reed, and Ringgenberg (2012)	Short sellers' trading advantage and public news about corporate events.	US: 3,167 unique firms over the period from January 3, 2005 to July 6, 2007.	A substantial portion of short sellers' trading advantage comes from their ability to analyze publicly available information. The well-documented negative relation between short sales and future returns is twice as large on news days and four times as large on days with negative news. The most informed short sales are not from market makers but rather from clients, and
Geczy, Musto, and Reed (2002)	Effect of actual short-selling costs and constraints on trading strategies that involve short selling.	US: 7,144 different stocks appear at least once over the sample period of November 1998 through October 1999.	The loans of initial public offering (IPO), DotCom, large-cap, growth, and low-momentum stocks are cheap, and investors who can short only stocks that are cheap and easy to borrow can enjoy at least some of the profits of unconstrained investors. Most IPOs are loaned on their first settlement days and throughout their first months, and the underperformance around lockup expiration is significant even for the IPOs that are cheap and easy to borrow. The effect of short-selling frictions appears strongest in merger arbitrage in that acquirers' (especially small ones') stock is expensive to borrow.

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Grundy, Lim, and Verwijmeren (2012)	Whether option strategies were substitutes for short sales during the September 2008 short-sale ban.	US: sample period 2008–2009, with a total of 467 stocks categorized into 71 ‘banned’ firms and 396 ‘unbanned’ firms.	The short-sale ban is associated with a decline in trade in put options on banned stock. The average daily put option volume for banned (unbanned) stock declines by 3,194 (490) contracts during the ban. No evidence is found to suggest that investors migrated to options of a particular moneyness during the ban. The authors conclude that a ban on short sales of stock is not overcome by trading in derivatives and that bearish derivative strategies are not effective substitutes for short sales during a short-sale ban.
Henry and Koski (2010)	Whether short selling around SEOs is informative or manipulative	US: a sample of 456 SEOs issued by 402 unique firms over the period January 2005 and December 2006	Around issue dates, higher levels of pre-issue short selling are significantly related to larger issue discounts for non-shelf-registered offerings. This evidence is consistent with manipulative trading.
Henry, Kisgen, and Wu (2015)	Short sellers trade by identifying firms that have significant changes in default	US: NYSE, AMEX, and Nasdaq 1,463 credit rating downgrades from April 1995 to December 2007.	In the month before a rating downgrade, equity short interest is 40 percent higher than one year previously. Short sellers predict changes in default probabilities that lead to downgrades by focusing on firms with inaccurate or biased ratings. This strategy is profitable for short sellers primarily since downgrades are associated with significantly negative equity returns. Short
Hirshleifer, Teoh, and Yu (2011)	Whether short sellers engage in short arbitrage of the accrual anomaly.	US: 91,121 firm-year observations of firms trading on the NYSE or Nasdaq over the period from June 1988 to December 2009.	A significant positive relationship between accruals and short interest is found, which is different from the finding of Richardson (2003). Furthermore, the authors document a significant positive interaction effect between accruals and institutional holdings (IOs), suggesting that, when shares are easier to borrow, there is more short arbitrage of the accrual anomaly. Abnormal return asymmetry (defined as a difference in the absolute values of top-decile and bottom-decile returns) is significantly negatively related to IOs, a finding that supports the notion that, when short arbitrage is more constrained, the short-side anomaly remains stronger than the long side of the anomaly.
Hobbs, Keasler, and McNeil (2012)	Short-selling behavior following the stock recommendations	US: 1,234 buy recommendations between February 2006 and December 2006.	There is a positive relationship between short selling and <i>Mad Money</i> buy recommendations. In addition, recommended stocks enjoy a positive abnormal return in the short run followed by a quick reversal (negative abnormal returns). These results suggest that short sellers act to exploit the short-term overpricing arising from the behavioral biases of some investors.

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	on <i>Mad Money</i> , a CNBC television show.		
Ho (1996)	Effects of severe short-sale restrictions on volatility and the leverage effect in	Singapore: 23 stocks from January 3, 1983 to September 4, 1987.	The volatility of stock returns increases when short sales are severely restricted. There is also evidence that short-sale restrictions suppress or reverse the asymmetric or leverage effect.
Huszár, Tan, and Zhang (2017)	Short sellers' trading strategies exploiting industry information.	US: 1,049,978 stock-month observations of Nasdaq stocks from January 1990 to June 2013.	In the industries with the highest aggregate shorted values, the most-shorted stocks earn about 1.54 percent lower abnormal returns than other highly shorted stocks in less shorted industries over the next 6 months. These results are likely to be driven by short sellers' preference for complex industries with the highest profit potential. The aggregate shorted value at
Jain, Jain, and Robin (2019)	Short selling and conditional conservatism.	US: final sample of 3,993 unique firms and 42,530 firm-years for the period 1995 to 2017.	Scaled short interest decreases with an increase in conservatism for both the level and the change in the C_SCORE-based conservatism measure and alternative conservatism proxies.
Jain, Jain, and Rezaee (2016)	Short selling and ESG performance.	US: 12,776 firm-year observations.	The authors document a negative association between short interest and ESG performance consistent with the notion that short sellers are interested in analyzing firms with unique CSR challenges that make their reported
Jones (2012)	Shorting restrictions during the 1920s and informational efficiency.	US: 30 Dow Jones Industrial average stocks for the 1931 downtick shorting prohibition, 1932 rule requiring written authorization to lend customer shares, and 1938 imposition of a strict uptick rule.	The average returns associated with the short-selling restriction events during the 1930s are reliably positive, which is consistent with limits to arbitrage and inconsistent with a full rational-expectations model. These regulatory changes also affect liquidity. For example, when the NYSE in 1932 required all brokers to obtain written authorization from customers before lending their shares, quoted bid–ask spreads widened. In contrast, both the downtick shorting prohibition of October 1931 and the tighter uptick rule of February 1938 improved liquidity.

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Jones and Lamont (2002)	Short-sale constraints and stock returns.	Loan rates (the direct monetary costs of shorting a stock) are collected for the 1926–1933 sample period with 8,310 monthly observations.	Stocks that are expensive to short have high market–book ratios but generate low subsequent returns, consistent with the hypothesis that they are overpriced. These stocks also tend to be small. The time pattern of market–book ratios and returns reveals that stocks have positive returns and rising valuations prior to being added to the loan list. Their market–book ratios peak when they are added to the list, and the excess returns thereafter are negative.
Karpoff and Luo (2010)	Short interest and financial misrepresentation.	US: 632 SEC enforcement actions for financial misrepresentation initiated from 1988 to 2005.	Average raw short interest SI_t increases steadily from month –19 to month 0, reaching a peak in month +5 before gradually decreasing to month +20. The patterns for all three measures of abnormal short interest are similar. The authors use three different proxies for severity: fraud, insider trading charges, and total accruals.
Kecskes, Mansi, and Zhang (2013)	Do short sellers provide predictive information to creditors in the bond market?	US: 10,594 firm-year observations on 1,714 firms covering a sample period from January 1988 through June 2011.	Firms with high short interest have lower credit ratings and are more likely to have their ratings downgraded. A 1 standard deviation increase in short interest increases the probability of a downgrade from 0.48 percent to 0.58 percent in the next month. Furthermore, firms with high short interest are associated with significantly higher bond spreads, with a 1 standard deviation increase in short interest increasing yield spreads by 26 basis points. Finally, a short-window return test documents negative and significant abnormal bond returns for large increases in short interest.
Keshk and Wang (2018)	Investor sentiment, short selling, and analysts' private information production.	US: the sample period is from 1986 to 2014 with 37,094 firm-year observations.	High short interest during a period of high investor sentiment provides market participants with a <i>credible</i> negative information signal that contradicts their expectations of good future firm performance. Such a contradictory signal motivates analysts to search for additional information. That is, analysts' earnings forecasts will produce and disseminate more private information. The authors find that the empirical evidence is consistent with this hypothesis.
Khan and Lu (2013)	Do short sellers front-run insider sales?	US: sample period 2005 to 2007 with 2,030 observations.	The authors find significantly positive <i>abnormal short sales</i> in the days <i>leading up</i> to large insider sales, peaking sharply on the day of the large insider sale (top 30 percent of all insider sales as a proportion of firm value). They find no such evidence for small insider sales. The evidence therefore supports the 'front-running' hypothesis. The front running appears to be concentrated in firms with poor accounting quality, suggesting that

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			information about a large insider sale reinforces short sellers' adverse opinion about firm value in the presence of poor accounting quality.
Lamont (2012)	Actions taken by firms to create short-sale constraints and their effects on stock returns.	US: stock returns for a sample of 266 similar firms that take anti-shorting actions over a 1977 to 2002 sample period.	Firms have very low returns in the year subsequent to taking anti-shorting action: they trail the market by about 2% per month, evidence that is consistent with the idea that short-sale constraints allow very substantial overpricing, which is corrected only slowly. The author also explores the behavior of short interest and prices around anti-shorting actions and finds very weak evidence that deliberate short squeezes (withdrawing shares from the stock loan market) can temporarily raise stock prices.
Lamont and Stein (2004)	Aggregate short interest and market valuation.	US: Graphical presentation of the short-selling activity during the 1995 dot-com period and short selling on the NYSE during the 1960–2002 period.	In contrast to cross-sectional evidence showing that short sellers target overvalued stocks, the evolution of aggregate short interest, both during the dotcom era and at other times in history, reveals that the total short interest moves in a countercyclical fashion. For example, the short interest in Nasdaq stocks <i>actually declines</i> as the Nasdaq index approaches its peak. The findings are more consistent with the argument that the open-ended nature of most professional arbitrage firms makes it difficult for these firms to exploit
Lasser, Wang, and Zhang (2010)	Effect of short selling on market reactions to earnings announcements.	US: sample period 1992 to 2003 with 56,853 security-quarter observations.	Short interest is positively related to stock returns for firms with extreme earnings surprises around quarterly earnings announcements, with the effect being stronger for good-news (the 3-day CAR increases by 0.06 percent for a 1 decile increase in relative SI) relative to bad-news events (a corresponding increase of 0.03 percent). Furthermore, short sellers tend to reduce their short positions more in heavily shorted firms when there is an extreme news release than when there is no extreme news. Finally, the authors show that the post-earnings-announcement drift (PEAD) is smaller (larger) for firms with a higher relative SI when an extreme positive (negative) earnings surprise is released.
Liu and Wu (2014)	Merger arbitrage short selling and price pressure.	US: sample period 2005 to 2007 with 290 merger announcements.	No abnormal short selling in stock acquirers is observable <i>ahead</i> of merger announcements, indicating that short sellers are <i>not informed</i> about upcoming mergers. However, the authors find a large increase of 9.2 percent in relative short interest on date 0, which climbs to over 11 percent the next day, suggesting highly elevated shorting activity. Correspondingly, the abnormal returns are large and negative with magnitudes of –1.26 percent and –2.15 percent on dates 0 and 1, respectively. The findings support

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Liu, Ma, and Zhang (2012)	Short sellers' informational efficiency during the subprime mortgage crisis.	US: sample period from 2005 to 2008 with 41 financial firms.	Short sellers accumulate short positions prior to write-down announcements, and stocks experience significantly negative returns around such announcements, suggesting short sellers' informational advantage. Furthermore, short sellers increase their positions significantly in the announcement month and keep increasing their positions afterward, suggesting the feedback effect; that is, after the disclosure of subprime-
Ljungqvist and Qian (2016)	Accelerating price discovery by small arbitrageurs facing severe short-sale	US: the sample contains 31 arbitrageurs who target 124 firms with 358 reports over the period from July 2006 to December 2011.	Arbitrageurs target companies with the most potential for overpricing or severe short-sale constraints. Despite these constraints, they manage to correct mispricing, as is evidenced by a 7.5 percent fall in prices when a report containing credible and difficult-to-ignore information is released to the public (current shareholders or the longs showing abnormally high
Lynch, Nikolic, Yan, and Yu (2014)	Short-selling activities and future stock returns.	US: a comprehensive database of short-sale transactions made available through Reg SHO.	A 1 standard deviation increase in daily aggregate shorting is associated with a decrease in market excess returns by up to 36 basis points over the following 10 trading days. Short sellers are informed about future aggregate earnings news, macroeconomic news, and investor sentiment.
Mashruwala and Mashruwala (2014)	Short-sale constraints, investor disagreement, and market reactions to earnings news.	US: sample period from 1989 to 2006 with 174,962 firm-quarter observations.	The 'torpedo effect' (negative asymmetry in earnings announcement returns for growth stocks) appears to be caused by overvaluation due to short-selling constraints and investor disagreement prior to the earnings announcement. There is no torpedo effect. By shorting overpriced stocks prior to the earnings announcement, short sellers offset the price effects of overoptimistic investors and thereby generate a symmetric price reaction to good and bad earnings news. The authors also observe the torpedo effect for
Massoud, Nandy, Saunders, and Song (2011)	Syndicated loans and short positions by hedge funds in the equity of borrowing firms.	US: borrowers trading on major US exchanges during Reg SHO: 4,315 loans consisting of 6,186 loan facilities.	The announcement effect of hedge fund loan borrowers is significantly negative (a cumulative abnormal return of -1.29% during the 5-day return window post-announcement) compared with that of bank borrowers. Thus, one potential profitable strategy is to short sell the equity of a borrower prior to a new loan announcement by taking advantage of the private information gathered during the lending process. The authors find supportive evidence in that the equity of the hedge fund borrowers is sold short prior to public

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McKenzie and Henry (2012)	Determinants of short selling.	Hong Kong: 17 stocks' daily short-selling information is sampled over the period January 2001 to April 2006.	Lagged short selling, dividend payments, company fundamentals, risk, option market trading, interest rate spreads, and lagged stock returns all influence the level of short selling. Moreover, the information contained in past prices is short lived, as only the most recent data influence the trading decisions of short sellers.
Meng, Li, Chan, and Gao (2020)	Short selling and financial constraints.	China: sample period 2007 to 2017 with 17,907 firm-years, including 939 treatment firms (included in the shortable list), with 7,881 treatment firm-years and 1,704 control firms (unshortable throughout the sample period), with 10,026 control firm-years.	Short sales generally worsen a firm's financial constraints by reducing its ability to raise cheap and overvalued external capital, a finding that is consistent with negative information theory. A shortable firm's financial constraints deteriorate more seriously in the case of higher credit risk or information asymmetry. Furthermore, shortable stocks receive more negative media coverage, exacerbating financial constraints. Finally, the authors find that the adverse impact of short sales on financial constraints is more pronounced for inefficient state-owned firms. They find some evidence of a 'deterrence effect,' which eases financial constraints by allowing short sales to play a disciplining role, but such an effect is much weaker than the
Meng, Li, Jiang, and Chan (2017)	Short selling prior to analyst downgrades.	China: 959 firm-level downgrade announcements from March 2010 to August 2014.	There is no abnormal short selling in the days before downgrade announcements in the full sample. However, for the star (non-star) analyst subsample, there is significant (insignificant) abnormal short selling beginning 10 days prior to downgrade announcements: star analysts might
Park (2017)	Do short sellers target firms with more real earnings management (REM) activities?	US: 24,979 firm-year observations over the 1989–2014 sample period.	Firms with higher levels of REM through sales manipulation and overproduction have greater subsequent short interest. This positive relationship is more pronounced for firms experiencing greater costs for accrual-based earnings management (AEM), for example firms with low accounting flexibility or firms facing stricter scrutiny from a high-quality auditor. Short sellers also appear to respond more to REM signals than other fundamental signals of firm overvaluation. Taken together, the evidence suggests that short sellers trade on REM information and incorporate the substitutive nature of REM versus AEM.

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Pownall and Simko (2005)	The information intermediary role of short sellers.	US: sample period 1989 to 1998 with 2,304 short-interest spikes associated with 1,333 firms.	The mean abnormal return around ‘abnormal short interest increase’ announcements is significantly more negative for firms with a <i>low analyst following</i> , consistent with short sellers providing value-relevant information in the absence of alternative sources of guidance. For firms with a <i>high analyst following</i> , the market response is dependent on earnings levels, consistent with investors viewing a short-interest increase as providing
Purnanandam and Seyhun (2018)	Short selling and informational efficiency.	US: sample period from 1991 to 2011 with more than 6000 stocks in the sample.	Short-selling activities are considerably informative about future stock returns when there is a higher likelihood of private information in stocks, as measured by insider-trading activities. Short sellers also provide considerable additional information to the market: information that is not fully captured by contemporaneous insider trading. The authors show this by investigating the portfolio of zero-insider-trading months and showing that short-selling activities are predictive of future returns for small stocks. Overall, the evidence suggests that short sellers improve the informational efficiency of market prices.
Rapach, Ringgenberg, and Zhou (2016)	Short interest and aggregate stock returns.	US: 504 monthly observations for January 1973 to December 2014.	Short interest is arguably the strongest known predictor of aggregate stock returns. In addition, short interest can generate utility gains of over 300 basis points per annum for a mean–variance investor.
Richardson (2003)	Short selling and earnings quality.	US: 1990–1998 sample period with a total of 12,195 firm-year observations.	Short sellers do not appear to utilize the information in operating accruals about future earnings, thereby allowing the accrual anomaly (1996) to exist. An alternative explanation is that high-accrual firms are riskier and more costly to sell short. The author finds some support for this alternative explanation.
Saffi and Sigurdsson (2011)	Short selling and price efficiency.	Global: 2005 to 2008 comprising 12,621 stocks in 26 countries.	Stocks with a limited lending supply (more short-sale constraints) are associated with lower efficiency. A higher level of lending supply (fewer SS constraints) is associated with fewer occurrences of extreme price increases but is not linked with extreme price decreases. Finally, a smaller lending supply and higher loan fees are associated with greater downside risk and higher total volatility, thereby confirming the academic finding that short-sale restrictions generally make markets less efficient.

Author(s)/year	Research issue(s)	Sample	Findings
Senchack and Starks (1993)	Short-sale restrictions and market reactions to short-interest announcements.	US: The data consist of all NYSE and ASE companies for which short-interest figures are published from January 1980 through December 1986.	Stocks with unexpected jumps in short interest experience negative abnormal returns. However, the stock price reaction differs for stocks with tradable options versus those without tradable options. According to Diamond and Verrechia (1987), options can reduce the cost of establishing a short position. Thus, the existence of tradable options can affect the magnitude of price adjustments to public information. Because the existence of tradable options reduces the costs of short selling and because option trading is observable, the information contained in an unexpected high short-interest announcement is more likely to be publicly known already.
Seneca (1967)	Short sales as a predictive variable for stock price changes.	US: sample period 1946 to 1965 with a total of 235 observations.	A large volume of short sales does not precipitate subsequent stock price behavior; rather, it is a prediction based on many issues—economic, political, and psychological—that present conditions that point to a price downturn. Simply put, short sales act as a predictor rather than a causal
Shi, Wang, and Zhang (2017)	Short selling and crediting rating agency (CRA) announcements.	US: the sample includes 696 (395) negative (positive) credit watch placements and 510 (398) rating downgrades (upgrades) during 2004 to 2009.	Abnormal short selling increases toward negative CRA announcement dates. It is highly significant before negative credit watches and certain types of rating downgrade announcements, for example mult notch downgrades and downgrades without prior negative credit watches. Two-day post-announcement stock returns are also abnormally low, and the severity of the post-event price decline is <i>positively</i> associated with the degree of abnormal short-selling days before the announcements.
Shkilko, Ness, and Ness (2012)	Short selling and intraday price pressures.	US: sample period July 2005 to June 2006.	The authors examine episodes of significant intraday downward price pressure in individual stocks and find that price declines during such periods are driven mainly by the nonshort volume. Although short sellers during these periods are also active and are responsible to some extent for such price declines, their influence on prices is secondary to that of nonshort sellers. The findings therefore cast doubt on the allegation that short sellers engage in abusive trading.
Shyu, Chan, and Liang (2018)	Informativeness of short selling on margin buying activities around corporate earnings announcements.	Taiwan: a total of 17,808 earnings announcement events during the period 2001–2012.	(i) Both short-selling and margin-buying activities are effective in improving the price efficiency, but the effect of short selling on price efficiency is stronger than that of margin buying; (ii) for the stocks without the uptick rule, short selling has significant information spillover effects on margin buying around earnings announcements, especially for firms with negative earnings surprises; (iii) the removal of the uptick rule significantly improves

Author(s)/year	Research issue(s)	Sample	Findings
			stock price informativeness (reduced price synchronicity) and favors more informed trading.
Singer, Wang, and Zhang (2018)	Do short sellers target firms with an upcoming revelation of internal control material weaknesses	US: sample period 2004 to 2010 with a total of 709 firm-year observations.	The authors find a progressive accumulation of short interest in the months leading to the triggering event (from 18 months to 1 month prior to the event) but only for firms with more severe ICMWs (defined as firms reporting at least three ICMWs). Additional analyses suggest that short sellers obtain unique information (incremental to firm parameters that are known to be associated with internal control failure), as their trades contain incremental prediction power regarding upcoming IC failure. This
Sobaci, Sensoy, and Erturk (2014)	Short-selling activity and market dynamics.	Turkey: the sample covers the period from January 2005 to December 2012.	Short sellers are contrarian traders and contribute to an efficient stock market in Turkey. Moreover, short-selling activity is associated with higher liquidity and decreased volatility.
Stambaugh, Yu, and Yuan (2015)	Arbitrage risk, arbitrage asymmetry, and idiosyncratic volatility (IV).	US: sample period from August 1965 to January 2011.	Stocks with greater IV, and thus greater arbitrage risk, are more susceptible to mispricing, which arbitrageurs do not eliminate; these features are evident in overpriced stocks. Similarly, the IV effect should be positive among underpriced stocks. Arbitrage asymmetry, however, postulates that arbitrage should eliminate underpricing more than overpricing: the negative IV effect among overpriced stocks should be stronger (particularly for stocks with low institutional ownership, which impedes easy short selling) than the positive IV effect among underpriced stocks, thereby sustaining the IV puzzle.
Takahashi (2010)	Short-sale inflow and stock returns.	Japan: the data cover 2156 firms listed on the Tokyo Stock Exchange from December 1997 to March 2008.	The least heavily shorted stocks outperform the most heavily shorted stocks by 0.707% over the next month, which persists for up to three months. In addition, this outperformance is not confined to stocks with high information asymmetry.
Zhao, Li, and Xiong (2014)	Short-sale constraints disperse pessimistic	China: February 12, 2010 to August 20, 2013, with a total of 511 stocks added to the short-selling qualification list.	Short-sale constraints are found to cause stock overvaluation, which is primarily attributed to distortions associated with pessimistic beliefs. However, the lifting of the short-sale ban improves market efficiency at the individual stock level by lowering the volatility, skewness, and extreme value frequency of stock returns.

Author(s)/year	Research issue(s)	Sample	Findings
	beliefs and market efficiency.		

TABLE A2. Short selling and real economic decisions

Author(s)/year	Research issue(s)	Sample	Findings
Chang, Lin, and Ma (2019)	Short-selling threats and merger and acquisition (M&A) decisions.	US: the sample consists of 452 domestic M&A transactions from 2003 to 2012.	Acquirers with higher short interest gain higher M&A announcement returns, supporting the hypothesis that acquirers with a stronger short-selling threat are less likely to conduct value-destroying deals. This is facilitated through short-selling activities around M&A announcements that accurately reflect acquirers' intrinsic value. The effect is stronger when acquirers are more likely to be targets of subsequent hostile takeovers and when their managers' wealth is more linked to stock prices.
Chen, Zhu, and Chang (2019)	Short-selling constraints and corporate payout policies.	US: sample period 2001–2010 with a total of 13,414 firm-year observations.	The authors find that, for pilot firms, only those that are more vulnerable to increased short-sale risks increase their cash dividends during the Reg SHO program. These firms continue to pay higher cash dividends even after the pilot program ends. The share repurchase activity of pilot firms (relative to that of their peers) remains unchanged before, during, and after the Reg SHO program.
DeAngelis, Grullon, and Michenaud (2017)	Short-selling threats and executive incentive contracts.	US: data from 2004 containing 1,350 firms. The sample period is from the fiscal year 2001 to the fiscal year 2008, and this gives a maximum of 9,806 firm-year observations.	Using a difference-in-differences (DiD) approach, the authors find no evidence that pilot firms increase the provision of performance incentives (delta). On the other hand, pilot firms increase the convexity of compensation payoffs (vega) stemming from a change in the structure of new equity grants. Pilot firms increase the proportion of stock options. Further analysis shows that pilot firms increase the use of stock options while simultaneously decreasing the use of restricted stocks. They increase their e-index, or entrenchment index, probably because of increased career concerns due to short-selling threats.
Grullon, Michenaud, and Weston (2015)	Short-selling constraints and real economic decisions.	US: an unbalanced panel of 13,526 firm-year observations with 8,919 firm-year observations in the control group and 4,607 firm-year observations in the pilot group.	Small constrained firms in the pilot program reduce their capital expenditure relative to the control group. Firms in the pilot group with a big increase in short-selling activity exhibit larger reductions in investment and equity issuance. Small firms in the pilot program decrease their equity issues significantly during the experiment. The prices of pilot stocks are more sensitive to market-wide or firm-specific selling pressure.
Guo, Chi, and Cook (2018)	Short selling and tax avoidance.	US: a total of 43,773 firm-year observations for the period 2000–2013.	Short interest is negatively associated with subsequent tax avoidance levels after controlling for the known determinants of tax avoidance. The evidence is consistent with managers taking actions to minimize the negative effect of high short interest on firms' stock prices.
Hou, Meng, Zhang, and Chan (2019)	Short selling and the propensity to engage in corporate philanthropic (CP) activity.	China: a 2010–2015 sample period with 1,600 firm-year observations.	A firm is more likely to engage in CP activities in a given year in response to an increase in short-selling activity, a finding that is consistent with firms using CP to divert public attention. The evidence is more pronounced for firms that are less transparent, have poor operating performance, have ineffective corporate governance, and anticipate future security violation.

TABLE A3. Short selling, financial reporting, and auditing outcomes

Author(s)/year	Research issue(s)	Sample	Findings
Blau, Brough, Smith, and Stephens (2013)	Short-selling activity surrounding auditor changes.	US: sample period from January 1, 2005 to December 31, 2006. The final sample includes 409 firms that change auditor during	SS activity increases significantly on and shortly after the announcement of an auditor change, particularly when (a) the company changes from a Big 4 to a non-Big 4 auditor (i.e. downgrade), (b) the change is due to an auditor resignation, and (c) an auditor–client disagreement is noted. Furthermore, short selling during the post-announcement period leads to significantly higher short-selling revenues for ‘downgrades’ and ‘auditor resignation’ cases.
Cassell, Drake, and Rasmussen (2011)	Short interest and audit fees.	US: sample period 2000–2008; the sample contains 33,991 firm-year observations.	The results indicate that there is a positive and significant association between audit fees and short interest, which strengthened after 2002. Furthermore, change specification suggests that auditors respond to information reflected in short interest, but there is no support for the explanation that short sellers respond to information reflected in audit
Chen, Cheng, Luo, and Yue (2019)	Short selling and the long-run management earnings forecasts.	US: 32,302 firm-quarters from 2,182 firms, including 738 pilot firms and 1,444	Pilot firms increase <i>good-news</i> disclosures to mitigate the downward pressure on stock prices. The increase is more pronounced when managers’ forecasts are of higher quality, when there is greater uncertainty regarding firm value, and when managers have higher equity incentives.
Clinch, Li, and Zhang (2019)	Short selling and management earnings forecasts.	US: December 2002–July 2009 with 55,104 firm-quarter observations.	Pilot firms increase the likelihood of voluntary quarterly <i>bad-news</i> management forecasts; provide these forecasts in a timelier manner; and accelerate the release of bad earnings news compared with control firms. Each of these effects is stronger for subsamples of moderate (compared with extreme) bad news, firms facing high (relative
Deng, Gao, and Kim (2020)	The relation between short-sale constraints and stock price crash risk.	US: the treatment sample consists of 776 pilot firms and the control sample consists of 1734 non-pilot	The lifting of short-sale constraints leads to a <i>significant decrease</i> in stock price crash risk by constraining managerial bad-news hoarding and improving corporate investment efficiency.
Drake, Myers, Myers, and Stuart (2015)	Short interest and earnings informativeness.	US: 53,368 firm-year observations from 1988 to 2009.	The short interest and future earnings response coefficients (FERCs) are positively related. The positive association is stronger in firms with a weak information environment and in firms with high future earnings growth expectations. Their results are not subject to a reverse causality problem (short sellers are attracted to firms with high FERCs), as they find that the lagged short interest is positively associated with the
Fang, Huang, and Karpoff (2016)	Short selling and earnings management in the context of Reg	US: sample periods of 2001–2003 and 2005–2010, with 9,873 firm-year observations.	Earnings management proxied by the magnitude of discretionary accruals, the propensity to meet and/or beat the analyst forecast and quarterly EPS, and the probability of being classified as a misstating firm is significantly lower for the pilot firms during the pilot period compared with the pre-pilot period.

Author(s)/year	Research issue(s)	Sample	Findings
Hope, Hu, and Zhao (2017)	Short-selling threats and audit fees.	US: sample period 2000 to 2013, with 16,483 firm-year observations.	Ex-ante SS threats significantly increase audit fees for pilot firms. This effect is more pronounced for client firms with higher bankruptcy risk and for firms with managers who are less likely to be disciplined (proxied by the presence of overconfident CEOs) by short-selling threats. Finally, the risk-shifting premium channel, as opposed to the increased audit effort channel, is found to be responsible for an increase in audit fees.
Hu, Lu, Ma, and Ye (2019, forthcoming)	Short selling and the cost of equity capital.	China: sample period 2007–2016, with 12,696 firm-year observations.	The removal of the short-selling ban in China reduced the cost of equity capital, a finding consistent with the disciplining effect of short-selling activity. In addition, firms with more short-selling activity incur less earnings management, higher market liquidity, and higher investment efficiency. Further evidence shows that firms' cost of equity increases when their stocks are no longer eligible for short selling.
Jiang, Qin, and Bai (2020)	Short-selling threats and real earnings management.	International: sample period 2003–2015, with a total of 122,591 firm-year observations from 22 countries.	Short-selling threats constrain real earnings management, an effect that is mainly driven by firms operating in countries with weak shareholder protection. This suggests the presence of a substitutive monitoring effect of country-level shareholder protection and short-selling threats at the firm level. Furthermore, the monitoring effect of short sales is more pronounced in countries where short sales are not only <i>legal</i> but also <i>feasible</i> .
Jin, Lin, Yang, and Zhang (2018)	Short selling and conditional conservatism.	China: January 2007 to December 2014, with a total of 1,820 firm-year observations.	Short-selling threats significantly increase conditional accounting conservatism, supporting short sellers' disciplining effect hypothesis. The effect is more pronounced for state-owned enterprises. Furthermore, accounting conservatism decreases significantly for firms that are removed from the short-selling eligibility list. Finally, the authors document a decrease in accounting conservatism in firms that experience an increase in abnormal short selling, a finding that corroborates managers' incentives to
Li and Zhang (2015)	Short selling and management voluntary disclosures.	US: 2003–2007 sample period, including 8,150 quarterly point and range good-news and bad-news management	Managers respond to short-selling pressure and price sensitivity to bad news by reducing the precision of bad-news forecasts. Managers also reduce the readability of bad-news annual reports in response to short-selling threats. These findings together highlight the managerial incentives for maintaining the current level of stock prices.
Massa, Zhang, and Zhang (2015)	Short selling and earnings management.	Global sample of 61,624 firm-year observations from 33 countries over the 2002–2009 period.	The empirical evidence supports the disciplining as opposed to the price pressure hypothesis in that SS is significantly negatively related to earnings management. In addition, the authors find that global regulations restricting short selling accentuate earnings management. Furthermore, they find a growing disciplining impact of short selling on earnings management over time. Finally, they document a positive relationship between short selling and stock price informativeness, a relationship that is more pronounced when the potential impact of short selling on earnings management is

Author(s)/year	Research issue(s)	Sample	Findings
Ni and Zhu (2016)	Short-selling constraints and stock price crash risk.	China: sample period 2008 to 2014 with 33,628 firm-quarter observations.	Using the 2000 regulatory change that allowed some A-share stocks on a designated list to be sold short, the authors document an increase in price crash risk for stocks included in this list. This is consistent with the notion that, when prices decline, uninformed investors assume that informed investors (short sellers) receive negative information, which leads the former group to reduce their demand for assets and drive the price of stocks even lower. However, the causal relation between short sales and stock price
Young (2016)	Short selling and conditional conservatism.	US: 3,801 firm year observations during the 2004–2006 sample	Conditional conservatism decreases with a decrease in short-selling constraints for a random sample of Reg SHO stocks, a finding that is consistent with managers of pilot firms delaying the recognition of bad news in earnings and hence affecting financial

TABLE A4. Miscellaneous

Author(s)/year	Research issue(s)	Sample	Findings
Boehme, Danielsen, and Sorescu (2006)	Short-sale constraints, differences of opinion, and overvaluation.	US: sample period 1988 to 2002 with 179 calendar month return tests.	Although Miller (1977) hypothesizes that the dispersion of investor opinion in the presence of short-sale constraints leads to stock price overvaluation, empirical tests of Miller's hypothesis examine the valuation effects of only one of these two necessary conditions. Boehme et al. (2006) examine the valuation effects of the <i>interaction</i> between differences of opinion and short-sale constraints and find that significant overvaluation only exists for stocks that are subject to <i>both</i> conditions simultaneously (the annualized raw returns of the most short-sale constrained, high dispersion stocks are between -9.1%
Boulton, Smart, and Zutter (2020)	The impact of country-level short-selling constraints on initial public offerings (IPO)	Cross-country: 14,964 IPOs from 37 countries.	IPO underpricing tends to be greater in countries that ban short selling or security lending and in countries where short selling is not practiced. Non-positive first-day returns are more common in countries where short selling is allowed, security lending is allowed, and short selling is commonly practiced. Higher-quality information environments may partially alleviate the effects of short-sale constraints on underpricing.
Danielsen and Sorescu (2001)	Option introduction, short interest, and negative price reaction to option	US: 1948 listing events categorized as call-only or put-call joint listings over the 1973–1995 period.	The negative price effect of option introductions post-1981 is cross-sectionally related to contemporaneous increases in the level of short interest of the underlying stock. This relationship is also affected by the firm beta and by the dispersion of investor expectations of future share price performance.
Figlewski (1981)	The informational effects on the restrictions on short sales.	US: sample period 1973 through 1979 with a total of 414 companies.	Figlewski (1981) finds some weak evidence that more heavily shorted firms underperform less heavily shorted firms. While his least-shorter firms produce positive abnormal returns with high statistical significance, the most-shorter deciles do not produce statistically significant negative abnormal returns.
Frino, Lecce, and Lepone (2011)	The impact of the 2008 short-selling bans on market quality.	Cross-country: 14 equity markets' daily data over the period January 1, 2007 to December 31, 2008.	Restrictions on short selling lead to artificially inflated prices indicated by positive abnormal returns; quality is reduced during the restrictions, as evidenced by wider bid–ask spreads, increased price volatility, and reduced trading activity.

Author(s)/year	Research issue(s)	Sample	Findings
Hasan, Massoud, Saunders, and Song (2015)	Whether short-selling activity before the 2008 short ban on financial companies reflects	US: 536 financial companies on the short-sale ban list in 2007.	Short sellers sell short stocks that have the greatest asset and insolvency risk exposures, and the short selling of financial firms' stocks is not significantly greater than that of non-financial firms after matching firm size and insolvency risk. When the short ban is in effect, the market quality of financial stocks without subprime asset exposure deteriorates to a larger degree than that of financial companies with subprime asset exposure.
Lensberg, Schenk-Hoppé, and Ladley (2015)	Costs and benefits of short-selling bans.	US: 8 million observations over 10,000 trading days.	A short-selling ban reduces both short-term volatility and long swings in asset prices, which positively affects price discovery and lowers the cost of capital. There is no adverse effect on transaction costs, but liquidity is worse in terms of the trade volume and order book depth.
Reed, Samadi, and Sokobin (2019)	Short sales and venue choice.	US: a matched sample considering stocks that trade in both dark pools and exchanges. The final database spans the period from August 2012 to June 2014 and contains	Short sellers exploit their information advantage relatively more on exchanges than in dark pools. Short sales comprise 45.68 percent of a stock's exchange volume and 37.04 percent of a stock's dark-pool volume on average. This venue choice is particularly pronounced when there is greater competition among short sellers to trade and when information is short lived. Although all venue short sales are informative about future prices, exchange short sales are the most informative: heavily shorted stocks underperform lightly shorted stocks over the next 20 days by an average of 0.89 percent on exchanges versus 0.53 percent in dark pools.