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ORIGINAL RESEARCH

Is managerial rent extraction associated with tax aggressiveness? Evidence from informed insider trading

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Abstract
Despite the agency perspective of corporate tax avoidance, there is little empirical evidence that managers do extract rents derived from aggressive tax practices. This study investigates the association between tax aggressiveness and managerial rent extraction by focusing on informed insider trading, a self-serving action with an unambiguous impact on insiders' personal wealth and representing the most direct channel through which managers expropriate outside shareholders. We find that insiders at firms more aggressive in tax avoidance gain significantly higher returns from insider purchases than insiders in less aggressive firms and this outperformance results from trading on future earnings news. We also find that insiders under the cover of aggressive tax practices more likely trade on bad news through insider sales and gain more from these trades. The overall evidence is consistent with aggressive tax planning serving managerial interests through gainfully exploiting private information and extracting rents from uninformed shareholders.

Keywords Tax avoidance · Insider trading · Rent extraction

JEL Classification G14 · H26 · D27

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1 Introduction

A major advancement in corporate tax research is the incorporation of the agency dimension into corporate tax avoidance decisions. Traditional theories view benefiting shareholders as the sole motive of corporate tax avoidance (Phillips et al. 2003); in an agency framework, however, Desai (2005) and Desai and Dharmapala (2006) propose a complementary relationship between aggressive forms of tax avoidance and managerial rent extraction. The agency view of tax avoidance has been widely adopted to develop predictions and interpret empirical results (e.g., Chen et al. 2010; Kim et al. 2011). However, recent research questions the relevance and merits of this perspective (Blaylock 2016; Armstrong et al. 2015). More specifically, as pointed out by Armstrong et al. (2015), it is unclear whether "managers do actually extract rents generated by tax avoidance" and precisely through which channels if they do. In this study, we seek to provide empirical evidence on the association between tax aggressiveness and managerial rent extraction by examining the link between aggressive tax practices and informed insider trading, a self-serving act that diverts rents from uninformed shareholders.

Informed insider trading is considered undesirable by shareholders and prohibited by laws and regulations. However, extant evidence suggests that insiders seem to engage in informed trading by exploiting superior information and gain over market participants (e.g., Ke et al. 2003; Piotroski and Roulstone 2005; Ravina and Sapienza 2010; Huang and Chan 2011). In addition, prior literature finds that insider trading profits increase with the level of information asymmetry between managers and outside investors (Frankel and Li 2004; Aboody and Lev 2000; Huddart and Ke 2007). Informed insider transactions have an unambiguous impact on insiders' personal wealth and represent the most direct means through which managers expropriate outside shareholders. Thus, insider trading provides an ideal setting to examine managerial rent extraction associated with tax aggressiveness.

Tax aggressiveness can facilitate informed insider trading by providing insiders greater latitude to exploit their information advantage. First, aggressive tax avoidance strategies require complexity and opacity to avoid detection (Desai and Dharmapala 2006, 2009b). Organizational and operational complexity baffles outsiders' ability to understand what is truly happening within the firm and thus widens the information gap between managers and uninformed shareholders (Bushman et al. 2004). Second, the informational problem is further exacerbated by managers' deliberate obfuscation of aggressive tax transactions. For example, managers may employ opaque reporting to hide the purpose and substance of underlying transactions or even conceal certain transactions (Desai and Dharmapala 2006; He et al. 2020). Deliberate obfuscation and distortionary reporting obscure the underlying sources of firm profitability and limit the flow of firm value-relevant information to shareholders. Third, managers can be shielded from shareholder monitoring under the excuse of tax saving. The lack of effective monitoring and control mechanisms affords managers even more leeway to gainfully exploit their informational advantage and makes rent extraction less costly for them.

Tax minimization activities range from benign and legal tax avoidance to most aggressive tax strategies such as tax shelters and tax noncompliance (Hanlon and Heitzman 2010). Given our focus on tax avoidance-facilitated managerial rent extraction, we are interested in empirical measures that capture the underlying constructs of most aggressive tax avoidance practices. Following prior studies (e.g., Hanlon and Heitzman 2010; Kim et al. 2011; Hoi et al. 2013; Lisowsky et al. 2013), we choose three measures to capture aggressive forms of tax avoidance: a common factor extracted from three book-tax differences (total

book-tax difference, permanent book-tax difference, and discretionary permanent book-tax difference), Wilson's (2009) tax sheltering probability, and Lisowsky's (2010) tax sheltering probability.

Because insider purchases are more likely driven by private information than insider sales (Ravina and Sapienza 2010; Jagolinzer et al. 2011), we rely on a large sample of insider purchase transactions over the period 1992–2017 to test whether tax aggressiveness is positively associated with insider trading profits. Our empirical results reveal a significantly positive relation between all three measures of tax aggressiveness and insider trading abnormal returns, implying that executives gain more along with firm's tax aggressiveness. Regarding the economic significance, a one standard deviation increase in the book-tax difference measure, Wilson's estimated tax sheltering probability measure, and Lisowsky's estimated tax sheltering measure each leads to a greater abnormal return that accounts for roughly 54% of the mean sample abnormal return of 0.052%. Hence, the impact of tax aggressiveness on insider trading gains seems material.

To provide further evidence that the outperformance of insiders from firms with aggressive tax positions is the result of trading on superior inside information rather than a reflection of investors' mimicking trading strategy (Davidson et al. 2015), we analyze the ability of insider purchases to predict future earnings surprises, a direct test of whether insiders trade on future news. We find that abnormal earnings announcement returns following insider purchases are significantly higher for firms with greater extent of tax aggressiveness, suggesting that insiders from those firms trade on future earnings innovations to gain higher returns. The overall evidence supports our hypothesis that aggressive tax practices increase information asymmetry between insiders and outside shareholders and thus enhance insiders' ability to extract information rents from uninformed shareholders by trading on superior information. Our inferences remain robust after accounting for the endogeneity of aggressive tax practices.

While it is difficult to use insider sales to test informational rent extraction as insider sales are generally not informative, prior studies find that insider selling preceding a negative information event is more likely to be motivated by private information (Beneish 1999; Beneish et al. 2012; Ravina and Sapienza 2010). To assess whether managers gainfully trade on bad news under the cover of aggressive tax practices, we examine insider trades preceding bad news. Using significant drops in earnings and stock prices to proxy bad news, we find that insiders in tax-aggressive firms are more likely to trade on bad news to benefit themselves than insiders in other firms, suggesting that aggressive tax practices furnish an opaque information environment which facilitates insiders' gains from both purchases and sales of own firms' stocks.

We conduct an array of robustness checks. To ensure that the documented association is not due to individual heterogeneity (i.e., managers' preferences or ability may drive both tax avoidance and inside trading profits), we control for managerial ability (observable individual attributes) and insider-fixed effects (unobservable individual characteristics) and find that the impact of tax aggressiveness on insiders' trading gains is not subsumed by insider heterogeneity. In addition, our results remain robust after controlling for corporate governance, executive equity risk incentives, earnings management, and firm-fixed effects, suggesting that our inferences are not driven by these factors and other time-invariant factors such as corporate culture.

Our study makes three contributions to the literature. First, we provide empirical findings that further our understanding of how aggressive tax avoidance practices facilitate managerial rent extraction through informed insider trading, thus adding a significant piece of evidence to the agency perspective of tax avoidance. Despite the intuitive appeal of the

agency theory of tax avoidance and its prevalent use in the literature for predictions and interpretations, very limited evidence exists confirming that managers do extract rents generated by tax avoidance activities (Armstrong et al. 2015). We use insider trading as an ideal setting to test avoidance-facilitated rent extraction and provide direct evidence that aggressive tax avoidance serves managerial rent extraction.

Second, our study adds to the large literature on the economic consequences of corporate tax avoidance. Extant literature examines shareholders' and debtholders' view of tax avoidance and provides mixed evidence (Kim et al. 2011; Lisowsky et al. 2013; Hutchens and Rego 2013; Hasan et al. 2014). The conflicting findings reflect ambiguous effect of tax avoidance on shareholders and debtholders who view tax avoidance as potentially value-enhancing and risk-engendering (Rego and Wilson 2012). We examine executives' personal gains associated tax avoidance and document consistent evidence that aggressive tax practices have unambiguous impact on managers' personal wealth, suggesting an adverse consequence of tax avoidance on uninformed shareholders.

Finally, in addition to enriching the academic literature on tax avoidance and insider trading, our study is relevant to regulators in that it identifies an important firm attribute that contributes to insiders' trading advantage and trading gains. This identification is important as Huddart et al. (2007) posit that it "may prove helpful to regulators who design enhanced disclosures or other remedies to limit insiders' trading advantage." Our findings indicate that firms' aggressive tax planning strategies create an opaque environment for insiders to gain from uninformed shareholders on the capital market, highlighting the need for enhanced tax-related disclosures.

The rest of the paper proceeds as follows. Section 2 discusses literature background and hypothesis development. Data, sample selection, and research design are detailed in Sect. 3. Section 4 offers primary empirical analyses and results. Section 5 presents sensitivity analyses and Sect. 6 concludes the paper.

2 Related literature and hypothesis development

2.1 Incremental contribution in relation to contemporary studies

In a corporate setting, the motives of tax avoidance are not limited to minimizing the tax burden to benefit shareholders. Agency conflicts between managers and outside shareholders may complicate the motivations as well as the consequences of tax planning. In particular, tax minimization strategies may advance interests of managers in ways that are detrimental to shareholders. Desai (2005) and Desai and Dharmapala (2006) argue that aggressive tax avoidance transactions provide self-interested managers with means, masks, and justifications to engage in opportunistic activities. They thus conjecture strong complementarities or positive feedback effects between aggressive tax practices and managerial rent extraction. Desai (2005) provides anecdotal evidence showing how active tax management strategies Tyco employed enhanced managers' ability to extract rents and concealed their dealings from shareholders. The dealings include diversion of corporate funds for personal purposes, abuse of loan programs, unauthorized compensation, related party transactions, and insider trading. While such evidence is intuitively appealing, there is little systematic empirical evidence to show that aggressive tax avoidance practices facilitate managerial rent extraction.

The agency perspective of tax avoidance has received considerable attention and interest in the tax literature. Desai and Dharmapala (2006) find that managers with greater incentive compensation tend to reduce the level of tax sheltering, particularly in firms with weak governance arrangements. They interpret this as being consistent with managers with better interest alignment having stronger incentives not to extract rents, thus engaging in less tax avoidance. Hanlon and Slemrod (2009) document a negative market response to firm announcements of tax sheltering involvement and the adverse reaction is less pronounced for well-governed firms. This implies that investors' perception of tax shelters is associated with rent extraction, especially in weakly-governed firms. Desai and Dharmapala (2009a) find a positive relation between tax avoidance and firm value only for a subset of well-governed firms, which implies that tax avoidance is beneficial to shareholders only when governance mechanisms are effective and managerial rent extraction is minimal. Based on the argument that controlling shareholders in family firms are concerned about price discounts due to perceived rent extraction associated with tax avoidance, Chen et al. (2010) predict and find that family firms engage in less tax avoidance than non-family firms. He et al. (2020) document that tax avoidance is negatively associated with analyst coverage. Kim et al. (2011) report that firms with greater extent of tax avoidance are more prone to stock price crashes, which they believe is consistent with the agency view of tax avoidance; however, they emphasize that "it is not tax avoidance per se but, rather, the rent diversion and bad news hoarding associated therewith that causes stock price crashes." Overall, these studies employ the agency perspective of tax avoidance to build predictions and interpret empirical findings but do not directly test whether tax aggressive practices allow for greater rent extraction by managers.

Two recent studies have attempted to assess whether tax avoidance is associated with rent extraction and provide mixed results. Dhaliwal et al. (2011) focus on cash assets and find that investors discount the value of firms' cash holdings when the level of tax avoidance is high. They argue that their findings are consistent with investors perceiving tax avoidance as enabling rent extraction by managers. This contemporaneous market-based approach seems to assume that investors can see through the underlying motives and consequences of tax aggressiveness and impound the information into stock price. Another issue with this approach is the difficulty in identifying the specific channels through which tax aggressiveness advances managers' personal interests. Specifically, it is unclear whether tax planning affords managers incremental opportunities for outright diversion of cash resources for personal purposes and/or whether it facilitates managerial overinvestment with cash assets (use of cash). Even if such actions can be specified, it is difficult to observe them directly. Blaylock (2016) focuses on firms' future operating performance and two indicators of opportunistic behavior (overinvestment and low payouts to common shareholders), and finds little evidence that tax avoidance is associated with these measures of managerial rent extraction.

Due to the paucity of robust empirical evidence in support of managerial rent extraction, the merits and relevance of the agency perspective of corporate tax avoidance have been questioned recently (Armstrong et al. 2015). In this study, we seek to sharpen the analysis of this research question by assessing the relation between aggressive tax avoidance practices and informed insider trading, a direct mechanism by which managers, i.e., the informed insiders, extract rents from shareholders, i.e., the uninformed outsiders (e.g., Baiman and Verrecchia 1996).

2.2 Hypothesis development

Informed insider trading, which trades on material inside information, is considered undesirable by shareholders and illegal by regulators.[1] However, much of the prior insider trading literature suggests that insiders appear to profit from their inside transactions, especially purchase transactions, at the expenses of outside shareholders by trading on superior inside information (e.g., Ke et al. 2003; Piotroski and Roulstone 2005; Ravina and Sapienza 2010). More importantly, theoretical research suggests that insider trading gains increase with the extent of information asymmetry between managers and outside shareholders (e.g., Kyle 1985; Glosten and Milgrom 1985) and empirical studies confirm that information asymmetry enhances insiders' ability to profit over other market participants (e.g., Frankel and Li 2004; Aboody and Lev 2000; Huddart and Ke 2007).

To argue the association between tax aggressiveness and insider trading profits, we focus on how aggressive tax practices enhance insiders' informational advantage from three perspectives. First, tax planning increases organizational and operational complexity. As argued by Desai and Dharmapala (2009b), a critical dimension of corporate tax avoidance is complexity that can obscure it from detection by the tax authorities. Organizational and operational complexity poses challenges for outsiders to understand a firm's true business model and earnings pattern, and thus enhances insiders' information advantage (Bushman et al. 2004). For example, Enron designed exceedingly complicated tax shelters that were even difficult for reviewers from the Joint Committee of Taxation to understand the terms and purposes of those transactions. Similarly, the complexity created by active tax management strategies in Tyco left only a handful of individuals understand the full workings of Tyco.

Second, the informational issue engendered by organizational and operational complexity is further aggregated by intricate and opaque financial reporting arising from tax planning. As noted by Desai (2005), Tyco shifted pre-tax profits from countries with high tax rates to its many tax haven subsidiaries through complex techniques such as transfer pricing, which caused the percentage of income attributed to foreign sources to move wildly from 1998 to 2001 (from 38–82 to 52–77), while the revenue share of foreign sources was relatively constant. The distortion over distribution of earnings across various subsidiaries significantly obscured the true underlying sources of business profitability. In addition, some tax planning transactions are merely tax- and accounting-driven without any economic substance, undermining outsiders' ability to understand and predict firms' true earnings ability. For example, Enron's tax shelters designed as a means to manufacture accounting earnings hindered investor understanding of the sources of earnings.

Empirical evidence is generally consistent with tax avoidance being associated with reduced transparency and impaired information environment. Hanlon (2005) find that tax avoidance is negatively related to earnings persistence and Frank et al. (2009) document a positive relation between tax avoidance and accounting accruals. Chen et al. (2010) and Balakrishnan et al. (2019) use various measures of information transparency and find consistent evidence that tax avoidance reduces firm transparency. Crabtree and Kubick (2014) find that tax avoidance reduces the value-relevance of earnings to investors at the announcement date. Ayers et al. (2010) report a significant negative relation between

[1] See Securities and Exchange Acts of 1933 and 1934, Insider Trading Sanctions Act of 1984, and Insider Trading and Securities Fraud Enforcement Act of 1988.

changes in book-tax differences and changes in firm credit rating, and argue that the finding is driven by reduced information quality associated with increased book-tax differences.

Lastly, to the extent that operational and reporting complexity prevents outsiders from comprehending the true happenings within a firm, it undermines the monitoring of managers by auditors, regulators, and outside shareholders. More importantly, as stated by Kim et al. (2011), "mangers are able to justify the opacity of tax avoidance transactions by claiming that complexity and obfuscation are necessary to minimize the risk of tax avoidance arrangements being detected by IRS." Because tax avoidance manoeuvres shield managers from monitoring and discipline by governance control mechanisms, extracting rents from outside shareholders by gainfully exploiting superior information becomes less costly for managers.

Therefore, the complex and opaque tax arrangements limit the flow of value-relevant firm information to outside shareholders, which accentuates insider information advantage and insider trading gains. The risk of managerial rent extraction is further elevated by weakened control mechanisms on managerial behavior under the pretext of minimizing tax expenses and avoiding detection. Thus, aggressive tax practices offer managers incremental latitude to expropriate outside shareholders through informed insider trading. A case in point is Tyco, whose active tax management strategies facilitated its then CEO and CFO to profit from insider trading. We formalize our hypothesis as follows:

H1 There is a positive relation between aggressive tax avoidance and informed insider trading.

3 Research design

3.1 Sample and data source

We obtain insider trading information from the TFN Insider Filing Data Files (Form 4 filings) between 1992 and 2017.[2] To capture information-driven trading activities that are not the mechanical result of stock and option grants, we follow prior studies (e.g., Frankel and Li 2004; Ravina and Sapienza 2010; Jagolinzer et al. 2011) and include only open market purchases and sales. For each transaction, we require non-missing information on CUSIP identifier and other fields including transaction date, transaction price, and transaction shares. We exclude observations with transaction price less than $2 or transaction shares less than 100 as these transactions are less likely to be information-driven. We retain transactions that can be matched with CRSP. After applying these filters, we are left with 3,538,292 trades. We focus on trades by C-suite executives including CEO, CFO, CIO, COO, CTO, and presidents as these insiders are responsible for firms' financial and tax policies. There are 916,398 trades by these insiders. Then we net transactions of the same insider on the same day, which results in 311,517 net transactions by C-suite executives. After merging with Compustat, we get 305,853 net trades. Our last step is to require the availability of data on the tree tax aggressiveness measures and control variables to conduct

[2] Section 16(a) of the Securities and Exchange Act of 1934 requires insiders' trades to be publicly disclosed via the filing of Form 4 to the SEC. Insiders include officers and directors of the issuer as well as beneficial owners of more than 10% of any equity class of securities of an issuing company.

Table 1 Sample selection

Criteria	No. of obs.
Open market purchases and sales with non-missing information on CUSIP, transaction date, transaction price and transaction shares, transaction price greater than $2, transaction shares greater than 100, and non-missing information from CRSP (1992–2011)	3,538,292
Transactions by CEO, CFO, COO, CIO, CTO, and President	916,398
Net the transactions by the same insider on the same day	311,517
After merge with compustat	305,853
After requiring the data availability on control variables to conduct multivariate regressions	206,416
After requiring the data availability on three tax aggressiveness variables	105,024
Insider purchases	15,928
Insider sales	89,096

This table presents the sample selection process. The insider trading data are extracted from the TFN Insider Filing Data Files (Form 4 filings) between 1992 and 2017. After requiring only trades for C-suite executives, data availability from CRSP and Compustat, and other information, there are 105,024 trades left in our sample, of which 15,928 are net purchases and 89,096 are net sales

main regression analyses, which leaves us with 105,024 net trades, involving 11,625 individuals and 4446 firms. Of these transactions, 15,928 are net purchases and 89,096 net sales, consistent with prior evidence that insider sales occur more often than insider purchases. Table 1 details the sample selection process.

3.2 Measuring insider trading profitability

We are interested in inquiring whether aggressive tax avoidance facilitates managerial rent extraction through trading on private information. In an efficient market, if insiders do not have private information vis-à-vis the market, average insider trading profitability should be zero. Hence, analyzing abnormal insider trading returns provide a feasible way to infer whether insiders profit from trading on private information. Following prior studies (e.g., Ravina and Sapienza 2010; Jagolinzer et al. 2011; Gao et al. 2014), we use the four-factor Fama and French (1993) and Carhart (1997) model to control for market risk and obtain abnormal trading profits. Specifically, we estimate the following model over the 180 days following each transaction and treat the intercept (or alpha) as insider trading profits[3]:

$$Ri{-}Rf = \alpha + \beta 1(Rmkt{-}Rf) + \beta 2\, SMB + \beta 3\, HML + \beta 4\, UMD + \varepsilon, \quad (1)$$

where *Ri* is firm *i*'s daily stock return, *Rf* is the daily risk-free interest rate; R_{mkt} is the CRSP value-weighted market return, and *SMB*, *HML*, and *UMD* are the size, book-to-market, and momentum factors (Fama and French 1993; Carhart 1997); α (−α) is the average daily risk-adjusted return to a net purchase (sale), representing potential gains following purchases and potential losses avoided following sales. We express α ($-\alpha$) as percentage and denote the variable as *DailyRet* (180) in the paper. As noted by Jagolinzer et al. (2011), a trade-specific measure of profitability can avoid bias inherent in statistical tests of long-run

[3] We follow prior research and compute abnormal trading returns over the event window of (1, 180) because the "short-swing" rule of Section 16(b) of the 1934 Act imposes penalty on profits earned on trades made fewer than 180 days subsequent to prior trades.

buy-and-hold returns (Kothari and Warner 1997; Barber and Lyon 1997) and allow us to control for differences in risk across transactions.

3.3 Measuring aggressive tax avoidance

Researchers have developed a wide variety of measures in an attempt to capture tax avoidance, aggressiveness, and sheltering activities. As these measures represent different things in different settings, Hanlon and Heitzman (2010) suggest that researchers understand the underlying constructs of various proxies and carefully consider the appropriateness of chosen measures for a particular research question. Given our focus on how tax planning strategies facilitate managerial rent extraction, the most suitable empirical measures should be the ones that capture extremely aggressive tax planning practices.

Tax sheltering represents the most aggressive form of tax avoidance. We rely on Wilson (2009) and Lisowsky (2010) methods to estimate tax sheltering probability. Specifically, we estimate a Wilson tax sheltering probability using the model reported in Column 3 of Table 5 and a Lisowsky tax sheltering probability using the model in Column 2 of Table 4. The two methods are based on the same logit model of attributes of firms found to be engaged in tax sheltering activities, with different coefficients due to tax shelters identified from different sources and different periods.[4] We use both probabilities in our main analyses to mitigate concerns over possible measurement errors resulting from the small sample size in coefficient estimates on the logit model. As larger values represent greater likelihood of tax sheltering, we rank the estimated probabilities into percentiles each year and scale them to values between 0 and 1. The variables constructed this way are referred to as *Shelter_W* for Wilson (2009) measure and *Shelter_L* for Lisowsky (2010). Detailed variable definition is presented in "Appendix Table 9".

Another useful proxy for tax aggressiveness is book-tax difference (BTD) which measures the difference between accounting earnings and taxable income. Mills (1998) and Mills and Sansing (2000) find that firms with greater BTDs are more likely to be audited by IRS, consistent with the idea that BTDs may signal some extent of tax aggressiveness. Desai (2003) argues that increased levels of tax sheltering in the 1990s are at least partially attributable to increases in BTDs. Heltzer (2009) find evidence consistent with BTDs providing insight into a firm's relative level of tax reporting aggressiveness rather than relative level of financial reporting aggressiveness. Desai and Dharmapala (2006) and Wilson (2009) find that BTDs are larger for firms charged with engaging in tax sheltering activities. The overall evidence is consistent with BTDs capturing some elements of aggressive tax reporting and being informative of tax sheltering. We use three measures each to capture total book-tax differences, permanent book-tax differences, and discretionary book-tax differences (Frank et al. 2009). As each measure has its limitations and may reflect different tax aggressiveness dimensions, we extract a common factor from the three BTD measures, and refer to it as *FactorBTD*.

[4] Lisowsky (2010) extends Wilson's (2009) model by including more predictors. One of the key inputs in the expanded model is tax haven information for firm subsidiaries. Due to lack of readily available information on this input, we are unable to use this expanded model. However, Lisowsky (2010) also estimates the coefficients on Wilson's (2009) predictors.

3.4 Main regression model

To test whether aggressive tax avoidance enhances insiders' ability to extract informational rents, we estimate a regression model of trading profits on factors identified by prior studies to be associated with trading profitability and a variable proxying tax aggressiveness. We specify our regression model as follows:

$$\begin{aligned} DailyRet(180)_t = {} & \beta_0 + \beta_1 TaxAggressiveness_t \\ & + \beta_2 SizeMVE_{t-1} + \beta_3 PastRet_{t-1} \\ & + \beta_4 MTB_{t-1} + \beta_5 EP_{t-1} + \beta_6 R\&D_{t-1} \\ & + \beta_7 Loss_{t-1} + \beta_8 FSInformative_{t-1} \\ & + \beta_9 PastEarnAnnRet_{t-1} + \beta_{10} Analyst_{t-1} \\ & + \beta_{11} Volatility_{t-1} + \beta_{12} Turnover_{t-1} + \varepsilon_t, \end{aligned} \tag{2}$$

where *DailyRet (180)* is daily risk-adjusted return over the 180 days following insider transaction and *TaxAggressiveness* is one of the three tax aggressiveness measures (*FactorBTD*, *Shelter_W*, and *Shelter_L*).

Prior studies find that insider trading profitability is associated with firm size, past stock returns, information asymmetry, and investor interests in firms' stock. Specifically, Seyhun (1985) find that insiders buy more in small firms and sell more in large firms and Lakonishok and Lee (2001) report that insiders in small firms gain more from purchases. We control firm size using market value of equity (*SizeMVE*) at the beginning of the year in which the trades occur. Insiders are found to trade as contrarians, i.e., they trade against past stock returns and price multiples (e.g., Piotroski and Roulstone 2005; Lakonishok et al. 1994; Lakonishok and Lee 2001). To account for contrarian trading tendencies, we include past stock returns (*PastRet*) estimated as market-adjusted returns over the interval $(-380, -20)$ before the trade, market-to-book ratio (*MTB*), and earnings to price ratio (*EP*).

Information asymmetry between insiders and outside investors is considered one of the primary sources of insider trading gains. We include an array of variables to control for information asymmetry arising from different sources. Firms with larger R&D expenditures have greater information asymmetry, leading to higher insider trading profits (Aboody and Lev 2000). We control for the R&D factor using an indicator variable (*R&D*) to represent firms with positive R&D expenses. Firms with financial losses also suffer from greater information asymmetry and thus may affect insider trading returns. We follow Huddart and Ke (2007) and Brochet (2010) and include an indicator variable (*Loss*) to control for information asymmetry arising from firms' financial performance. We include financial statement informativeness (*FSInformative*) as Frankel and Li (2004) document evidence that financial statement infomativeness affects the insider trades' predictive ability for future stock returns. We follow Skaife et al. (2013) and compute *FSInformative* as the adjusted R^2 from a firm-specific time-series regression of price per share on book value and earnings per share using quarterly data over a 20-quarter period ending with the fourth quarter of fiscal year t. Given that Huddart and Ke (2007) report that market reactions to earnings announcements are strongly related to trading profits, we control for cumulative abnormal returns around quarterly earnings announcements over the past 5 years (*PastEarnAnnRet*). We also include the number of analysts following the firm (*Analyst*) because analyst coverage affects the dissemination of firm information and is found to be inversely related to insider trading profitability (Frankel and Li 2004).

Frankel and Li (2004) and Ravina and Sapienza (2010) find that stock return volatility can predict insider trading profits because a volatile environment enhances insiders' information advantage due to their superior information about the company. We follow prior studies and compute stock return volatility (*Volatility*) as the standard deviation of daily stock returns over the interval of (−380, −20) prior to the trade. The share turnover (*Turnover*), estimated as the average ratio of daily trading volume and common shares outstanding over the interval of (−380, −20) before the trade, is included to control for the intensity of investor interests. Following prior studies (e.g., Gao et al. 2014), we cluster standard errors by individual executive.

3.5 Summary statistics

Panel A of Table 2 reports summary statistics of trading profits for both insider purchases and sales. The statistics show that insider purchases earn an average daily risk-adjusted return of 0.052%, 0.072%, and 0.082% over the 180 days, 120 days, and 90 days following the trades, respectively, while the same-period buy-and-hold return is 4.097%, 3.881%, and 3.663%, respectively, consistent with those reported by Gao et al. (2014), Jagolinzer et al. (2011), and Wang et al. (2012). Correspondingly, the daily abnormal return for insider sales is −0.008%, −0.001%, and −0.000% and buy-and-hold return −0.082%, −0.349%, and −0.366%, not statistically different from zero. The findings concur with previous evidence that insider purchases reflect private information and insider sales may occur for reasons other than information.

Panel B of Table 2 presents summary statistics of tax aggressiveness measures for firm-years with insider purchase transactions. The mean (median) value of total BTDs (*TBTD*), permanent BTD (*PermDiff*), and discretionary permanent BTDs (*DTAX*) is −0.058 (−0.001), −0.055 (0.000), and 0.002 (0.001), respectively. The mean (median) value of tax sheltering probability based on Wilson (2009) (*Shelter_W*) and Lisowsky (2010) (*Shelter_L*) is 0.427 (0.400) and 0.422 (0.390), respectively.

We tabulate Pearson correlation matrix between the independent variables in Table 3. For tax aggressiveness measures, we find that BTD proxies are positively correlated with each other and the magnitudes are nontrivial, suggesting that these measures reflect some common dimensions of tax aggressiveness. In addition, we find that the correlations of common factor (*FactorBTD*) with three individual BTD proxies are all above 0.30, an indication that *FactorBTD* captures common constructs of the underlying individual measures. In addition to that the two tax sheltering measures are highly correlated with each other, they are each significantly correlated with *FactorBTD*, validating our choice of *FactorBTD* as a reasonable measure of tax aggressiveness. Correlations between control variables are generally small such that multicollinearity concerns are minimal.

4 Empirical tests and results

4.1 Tax aggressiveness and insider trading profits

4.1.1 Baseline model

We estimate Eq. (2) for purchase transactions with three tax aggressiveness measures as the dependent variable each at one time and report the results in Table 4. The coefficients

Table 2 Summary statistics

Variable	Mean	SD	P25	Median	P75
Panel A: trading profits					
Insider purchase (N = 15,928)					
DailyRet (180)	0.052	0.263	−0.094	0.045	0.199
DailyRet (120)	0.072	0.319	−0.112	0.058	0.246
DailyRet (90)	0.082	0.382	−0.134	0.069	0.288
BHR (180)	4.097	34.771	−17.721	−0.051	20.314
BHR (120)	3.881	27.558	−13.031	0.789	16.709
BHR (90)	3.663	23.645	−10.554	1.602	14.845
Insider sales (N = 89,096)					
DailyRet (180)	−0.008	0.214	−0.123	−0.009	0.108
DailyRet (120)	−0.001	0.263	−0.145	−0.005	0.139
DailyRet (90)	0.000	0.308	−0.169	−0.003	0.164
BHR (180)	−0.082	27.365	−16.191	−1.548	13.661
BHR (120)	−0.349	22.155	−13.175	−0.995	10.931
BHR (90)	−0.366	19.107	−11.189	−0.830	9.409
Panel B: tax aggressiveness measures (N = 4842)					
TBTD	−0.058	0.212	−0.062	−0.001	0.027
PermDiff	−0.055	0.214	−0.032	0.000	0.014
DTAX	0.002	0.169	−0.030	0.001	0.035
FactorBTD	0.184	0.159	0.196	0.228	0.240
Shelter_W	0.427	0.268	0.200	0.400	0.630
Shelter_L	0.422	0.268	0.190	0.390	0.630
Panel C: control variables (N = 4842)					
SizeMVE	5.765	1.585	4.608	5.609	6.759
PastRet	0.319	25.191	−0.137	0.000	0.000
MTB	3.141	4.439	1.257	1.958	3.238
EP	−0.006	0.127	−0.033	0.035	0.064
R&D	0.494	0.500	0.000	0.000	1.000
Loss	0.321	0.467	0.000	0.000	1.000
FSInformative	0.436	0.255	0.218	0.426	0.645
PastEarnAnnRet	−0.001	0.025	−0.015	−0.001	0.013
Analyst	1.593	0.709	0.000	1.792	2.303
Volatility	0.034	0.015	0.022	0.031	0.042
Turnover	−5.709	1.029	−6.439	−5.647	−4.938

This table presents summary statistics for trading profits (Panel A), tax aggressiveness measures (Panel B), and control variables (Panel C). The sample period spans from 1992 to 2017. There are 15,928 net purchases involving 4842 firms and 89,096 net sales. The tax aggressiveness measures and control variables are for firms with net insider purchases. Variables are as defined in "Appendix Table 9"

on all three tax measures are positive and significant, indicating that insiders from firms with greater tax aggressiveness earn higher abnormal returns than insiders from firms with less extent of tax aggressiveness. Specifically, the coefficient is 0.175 (t = 4.08) for *FactorBTD*, 0.105 (t = 7.52) for *Shelter_W*, and 0.106 (t = 7.55) for *Shelter_L*. As for economic significance, a one standard deviation increase in *FactorBTD*, *Shelter_W*, and *Shelter_L*

Table 3 Correlation matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
TBTD (1)	1															
PermDiff (2)	**0.929**	1														
DTAX (3)	**0.235**	**0.338**	1													
FactorBTD (4)	**0.968**	**0.992**	**0.317**	1												
Shelter_W (5)	**0.421**	**0.328**	**0.040**	**0.365**	1											
Shelter_L (6)	**0.425**	**0.333**	**0.039**	**0.369**	**0.996**	1										
SizeMVE (7)	**0.126**	**0.117**	−0.018	**0.122**	**0.192**	**0.224**	1									
PastRet (8)	0.004	0.004	−0.014	0.004	0.012	0.009	−0.016	1								
MTB (9)	**−0.249**	**−0.240**	**0.029**	**−0.246**	−0.005	−0.005	**0.177**	0.007	1							
R&D (10)	**−0.224**	**−0.210**	0.014	**−0.217**	**−0.130**	**-0.144**	**0.029**	0.015	**0.157**	1						
Loss (11)	**−0.376**	**−0.371**	**0.040**	**−0.377**	**−0.302**	**−0.310**	**−0.197**	0.021	**0.093**	**0.200**	1					
EP (12)	**0.356**	**0.349**	**−0.107**	**0.355**	**0.276**	**0.282**	**0.209**	−0.020	**−0.060**	**−0.175**	**−0.760**	1				
FSInformative (13)	**0.030**	0.023	−0.020	0.025	**0.060**	**0.063**	**0.034**	0.001	0.024	**−0.041**	**−0.070**	0.023	1			
PastEarnAnnRet (14)	**0.178**	**0.171**	**0.041**	**0.176**	**0.160**	**0.165**	**0.077**	−0.003	0.005	**−0.065**	**−0.181**	**0.156**	**0.034**	1		
Analyst (15)	**0.061**	**0.061**	−0.018	**0.062**	**0.110**	**0.135**	**0.763**	−0.014	**0.124**	0.004	**−0.128**	**0.129**	0.009	**0.075**	1	
Volatility (16)	**−0.272**	**−0.245**	0.023	**−0.257**	**−0.267**	**−0.290**	**−0.431**	0.020	**0.041**	**0.135**	**0.350**	**−0.367**	**−0.051**	**−0.075**	**−0.260**	1
Turnover (17)	**−0.100**	**−0.086**	**−0.029**	**−0.092**	**−0.082**	**−0.070**	**0.469**	0.005	**0.146**	**0.130**	**0.067**	**−0.054**	−0.013	−0.017	**0.532**	**0.118**

This table presents correlation matrix for tax aggressiveness measures and control variables used in baseline regression for 4842 firms with net insider purchases from 1992 to 2017. Correlation coefficients that are significant at the 5% or better level are in bold. Variables are as defined in "Appendix Table 9"

Table 4 Tax aggressiveness and insider trading profits

Variable	Coef.	t-stat.	Coef.	t-stat.	Coef.	t-stat.
Intercept	−0.184***	−3.53	−0.186***	−3.67	−0.184***	−3.64
FactorBTD	**0.175*** **	**4.08**				
Shelter_W			**0.105*** **	**7.52**		
Shelter_L					**0.106*** **	**7.55**
SizeMVE	−0.016***	−3.22	−0.014***	−3.43	-0.014***	−3.56
PastRet	0.000	1.51	0.000	0.90	0.000	1.03
MTB	0.001	0.65	−0.000	−0.27	−0.000	−0.26
EP	0.025***	2.88	0.023***	2.64	0.024***	2.71
R&D	−0.002	−0.18	0.002	0.15	0.002	0.18
Loss	0.002	0.04	0.021	0.39	0.023	0.42
FSInformative	0.024	0.91	0.021	0.79	0.021	0.78
PastEarnAnnRet	1.602***	9.11	1.630***	9.30	1.629***	9.29
Analyst	0.031***	3.73	0.026***	2.99	0.026***	2.97
Volatility	3.609***	10.30	3.707***	10.68	3.724***	10.72
Turnover	−0.017***	−3.32	−0.015***	−2.93	−0.015***	−2.93
N	15,928		15,928		15,928	
R^2	7.79%		7.87%		7.88%	

This table presents results of the relation between tax aggressiveness and insider trading profits. The sample includes 15,928 net purchase trades over the period 1992–2017. The regression model is as follows:

$$\begin{aligned} DailyRet\,(180)_t = {} & \beta_0 + \beta_1 TaxAggressiveness_t \\ & + \beta_2 SizeMVE_{t-1} + \beta_3 PastRet_{t-1} + \beta_4 MTB_{t-1} \\ & + \beta_5 EP_{t-1} + \beta_6 R\&D_{t-1} + \beta_7 Loss_{t-1} \\ & + \beta_8 FSInformative_{t-1} + \beta_9 PastEarnAnnRet_{t-1} \\ & + \beta_{10} Analyst_{t-1} + \beta_{11} Volatility_{t-1} \\ & + \beta_{12} Turnover_{t-1} + \varepsilon_t, \end{aligned}$$

where *TaxAggressiveness* is one of the three tax aggressiveness measures (*FactorBTD, Shelter_W, and Shelter_L*). Variables are as defined in "Appendix Table 9". Standard errors are adjusted for clustering at the individual level. Variables of interest are in bold

***, **, and * indicate significance at the 1%, 5%, and 10% levels with two-tailed test, respectively

leads to an increase in abnormal return of 0.028%, 0.028%, and 0.028%, respectively. Considering the mean (median) abnormal return of 0.052% (0.045%), the economic impact of tax aggressiveness on insider trading gains is remarkable. In addition, the extent of tax aggressiveness seems to capture substantial cross-sectional variations in abnormal trading profits as the R^2 increases by more than 10% after we include the tax aggressiveness measure (the R^2 is 6.93% when it is not included).

Turning to coefficients on the control variables, our results are generally consistent with prior studies. The coefficient on firm size (*SizeMVE*) is negative, consistent with Lakonishok and Lee (2001) that insiders from small firms profit more than insiders from large firms. We also provide some evidence that insider purchases are contrarian as the coefficient on earning-to-price (*EP*) ratio is positive. Similar to Ravina and Sapienza (2010), we document a positive (negative) relation between stock return volatility (trading volume) and insider trading profitability.

4.1.2 Controlling for endogeneity of tax aggressiveness

A possible limitation of our analysis is that firms' choice of tax aggressiveness and insider trading could be endogenously related, that is, insiders may opt for the two strategies simultaneously given that each is to influence the other. Specifically, when deciding tax planning strategies, insiders may anticipate the effect of tax aggressive activities on trades of their personal accounts and incorporate this expectation into tax management decisions. In this scenario, the tax aggressiveness variable is endogenous, which could lead to biased estimates.

We account for the endogenous nature of tax aggressiveness using instrumental variables and estimate the trading profit equation using the two-stage least squares (2SLS) technique. The implementation of 2SLS requires estimating two equations. The first stage involves modeling tax aggressiveness variables by regressing them on the instruments and exogenous variables. The predicated values of the endogenous variables from the first stage are then used in the trading profit equation in the second stage.

Following previous studies (e.g., Chen et al. 2010; Hoi et al. 2013; Rego and Wilson 2012), we model tax aggressiveness as follows:

$$\begin{aligned} TaxAggressivenss_t = {} & \beta_0 + \beta_1 Accrual_t \\ & + \beta_2 Cash_t + \beta_3 ROA_t + \beta_4 Leverage_t \\ & + \beta_5 NOL_t + \beta_6 ChgNOL_t + \beta_7 FIncome_t \\ & + \beta_8 PPE_t + \beta_9 INTANG_t + \beta_{10} EQINC_t \\ & + \beta_{11} SizeMVE_{t-1} + \beta_{12} MTB_{t-1} \\ & + \beta_{13} SGrowth_t + \varepsilon_t, \end{aligned} \tag{3}$$

where the dependent variable, *TaxAggressiveness*, represents one of the three tax aggressiveness measures (*FactorBTD*, *Shelter_W*, and *Shelter_L*). A set of variables are included to control for earnings quality (*Accrual*), firm performance (*ROA*, *NOL*, and *ChgNOL*), leverage (*Leverage*), foreign operations (*FIncome*), firm size (*SizeMVE*), firm growth (*MTB*, *SGrowth*), and other factors affecting tax aggressiveness (*PPE*, *INTANG*, and *EQINC*).

The 2SLS estimation requires at least one valid instrument that is related to tax aggressiveness, but not directly related to insider trading profits. We choose equity in earnings (*EQINC*) as an instrumental variable. *EQINC* captures differential book and tax treatments of consolidated earnings accounted for using equity method. As indicated in Panel A of Table 5, *EQINC* is significantly related to tax aggressiveness. There is no obvious reason that differential book and tax treatments of consolidated earnings affect insider trading returns. In fact, in untabulated estimates, we find little evidence that this variable is significantly associated with our measure of trading profits when included in the second-stage regressions, confirming the validity of *EQINC* as an instrumental variable.

Panel A of Table 5 reports estimates from the first-stage regression and Panel B shows results from the second-stage regression. The coefficients on control variables from the first-stage regression are generally consistent with predictions. More importantly, the direction and significance of the coefficients on the predicted tax aggressiveness variables remain unchanged after controlling for the possible endogeneity of tax planning choices, suggesting that the documented positive relation between aggressive tax avoidance and insider trading profits is not driven by the endogenous choice of tax avoidance.

Table 5 Tax aggressiveness and insider trading profits: controlling for endogeneity of tax aggressiveness

Variable	Coef.	t-stat.	Coef.	t-stat.	Coef.	t-stat.
Panel A: first stage regression						
Intercept	0.238***	35.92	0.313***	17.58	0.279***	15.74
AbAccrual	−0.091***	−2.87	−0.044	−0.80	−0.046	−0.85
Cash	−0.078***	−8.34	0.011	0.50	0.008	0.34
ROA	0.249***	2.83	0.160**	2.03	0.166**	2.09
Leverage	0.065***	7.35	0.044**	2.51	0.047***	2.66
NOL	−0.019*	−1.79	−0.062***	−4.99	−0.064***	−5.15
ChgNOL	−0.101***	−3.39	−0.141***	−4.18	−0.136***	−4.07
FIncome	0.454***	2.66	0.151	0.83	0.166	0.90
PPE	−0.101***	−7.20	−0.012	−0.59	−0.015	−0.73
INTANG	−0.008	−0.98	−0.012	−0.88	−0.013	−0.93
EQINC	0.365**	2.57	1.162***	3.30	1.179***	3.38
SizeMVE	0.002	1.44	0.026***	7.95	0.031***	9.70
MTB	−0.003***	−4.72	0.002*	1.79	0.002	1.51
SGrowth	−0.000	−0.65	−0.000	−0.53	−0.001	−0.75
N	4485		4485		4485	
R^2	61.18%		17.44%		19.00%	
Panel B: second stage regression						
Intercept	−0.155**	−2.39	−0.175***	−2.63	−0.167**	−2.54
FactorBTD	**0.185*** **	**3.58**				
Shelter_W			**0.204*** **	**3.88**		
Shelter_L					**0.203*** **	**3.85**
SizeMVE	−0.016***	−2.61	−0.019***	−3.24	−0.020***	−3.46
PastRet	0.000***	3.36	0.000***	3.71	0.000***	3.68
MTB	0.000	0.25	−0.001	−0.33	−0.001	−0.30
EP	0.020**	2.02	0.023**	2.34	0.023**	2.34
R&D	−0.001	−0.08	−0.001	−0.07	−0.001	−0.05
Loss	0.014	0.21	0.007	0.11	0.008	0.12
FSInformative	0.035	1.10	0.032	0.99	0.032	0.99
PastEarnAnnRet	1.655***	8.25	1.677***	8.41	1.676***	8.41
Analyst	0.026***	2.87	0.023**	2.49	0.023**	2.49
Volatility	3.559***	8.52	3.539***	8.51	3.539***	8.50
Turnover	−0.014**	−2.26	−0.013**	−2.12	−0.013**	−2.11
N	12,407		12,407		12,407	
R^2	7.56%		7.57%		7.57%	

Table 5 (continued)

This table presents results of the relation between tax aggressiveness and insider trading profits estimated from two-stage least squares approach (2SLS) to control for the endogeneity of aggressive tax avoidance. The initial sample includes 15,928 net purchase trades over the period 1992–2017 and the number of observations depends on data availability of variables used in the first-stage regression. The first stage regression model is as follows:

$$\begin{aligned} TaxAggressivenss_t = {} & \beta_0 + \beta_1 Accrual_t \\ & + \beta_2 Cash_t + \beta_3 ROA_t + \beta_4 Leverage_t \\ & + \beta_5 NOL_t + \beta_6 ChgNOL_t + \beta_7 FIncome_t \\ & + \beta_8 PPE_t + \beta_9 INTANG_t + \beta_{10} EQINC_t \\ & + \beta_{11} SizeMVE_{t-1} + \beta_{12} MTB_{t-1} \\ & + \beta_{13} SGrowth_t + \varepsilon_t, \end{aligned}$$

where *TaxAggressiveness* is one of the three tax aggressiveness measures (*FactorBTD, Shelter_W, and Shelter_L*)

The second stage regression model is as follows:

$$\begin{aligned} DailyRet\,(180)_t = {} & \beta_0 \\ & + \beta_1 PTaxAggressiveness_t \\ & + \beta_2 SizeMVE_{t-1} + \beta_3 PastRet_{t-1} \\ & + \beta_4 MTB_{t-1} + \beta_5 EP_{t-1} \\ & + \beta_6 R\&D_{t-1} + \beta_7 Loss_{t-1} \\ & + \beta_8 FSInformative_{t-1} \\ & + \beta_9 PastEarnAnnRet_{t-1} \\ & + \beta_{10} Analyst_{t-1} + \beta_{11} Volatility_{t-1} \\ & + \beta_{12} Turnover_{t-1} + \varepsilon_t, \end{aligned}$$

where *PTaxAggressiveness* is the predicted value from the first-stage regression with each of the three tax aggressiveness measures (*FactorBTD, Shelter_W, and Shelter_L*) as dependent variable. Variables are as defined in "Appendix Table 9". Standard errors are adjusted for clustering at the individual level. Variables of interest are in bold

***, **, and * indicate significance at the 1%, 5%, and 10% levels with two-tailed test, respectively

4.2 Tax aggressiveness and trading on future news

We interpret the higher abnormal returns as insiders from firms with tax aggressiveness being more likely to exploit superior information than insiders from other firms. However, as argued by Davidson et al. (2015), the higher abnormal returns may be caused by other investors mimicking trades of insiders. To ensure that insider outperformance does result from utilization of future value relevance information, we test whether the predictive ability of insider trades for future earnings innovations (surprises) varies with the extent of tax aggressiveness.

Earnings are an important valuation metric and accounting literature has consistently shown that the market reacts to unexpected earnings. That is, if the market does not anticipate earnings changes, announcements of earnings surprises are found to trigger unusual market responses. Following prior studies (e.g., Wang et al. 2012; Jagolinzer et al. 2011), we measure future earnings innovations as three-day cumulative abnormal returns (market-adjusted CARs) around quarterly earnings announcements following insider purchases. We choose all quarters in 1 year following purchases, and compute the mean and sum of all CARs in 1 year, and expect the extent of tax aggressiveness to be positively related to the CARs.

We study the relation between tax aggressiveness and predictive ability of insider purchases for future earnings surprises by estimating the following regression model:

Table 6 Tax aggressiveness and abnormal earnings announcement returns after insider purchases

Variable	Coef.	t-stat.	Coef.	t-stat.	Coef.	t-stat.
Panel A: multivariate analysis (dependent variable = AnnCAR_S)						
Intercept	0.000	0.02	−0.001	−0.30	−0.001	−0.16
FactorBTD	**0.082*****	**8.49**				
Shelter_W			**0.038*****	**8.62**		
Shelter_L					**0.040*****	**9.03**
SizeMVE	−0.002***	−3.15	−0.002**	−2.54	−0.002***	−2.84
MTB	0.001***	3.52	0.000	0.94	0.000	1.01
N	13,987		13,987		13,987	
R^2	0.68%		0.50%		0.54%	
Panel B: controlling for endogeneity of tax aggressiveness (dependent variable = AnnCAR_S)						
Intercept	0.015**	2.56	−0.000	−0.06	0.004	0.56
FactorBTD	**0.083*****	**6.78**				
Shelter_W			**0.110*****	**7.33**		
Shelter_L					**0.109*****	**7.48**
SizeMVE	−0.005***	−5.94	−0.008***	−8.19	−0.008***	−8.53
MTB	0.001***	4.60	0.001***	3.15	0.001***	3.26
N	10,858		10,858		10,858	
R^2	0.71%		0.90%		0.91%	

This table reports results of the relation between tax aggressiveness and abnormal earnings announcement returns of all quarters in 1 year following insider purchases. The initial sample includes 15,928 net purchase trades covering the period 1992–2017 and the number of observations depends on data availability of variables used in the analyses. Panel A presents results from the following regression analysis:$AnnCAR\_S_{t+1} = \beta_0 + \beta_1 TaxAggressiveness_t + \beta_2 SizeMVE_t + \beta_3 MTB_t + \varepsilon_{t+1}$, where *TaxAggressiveness* is one of the three tax aggressiveness measures (*FactorBTD, Shelter_W, and Shelter_L*). Panel B presents the second stage results from the two-stage least squares regression (2SLS) to control for the endogeneity of tax aggressiveness. Variables are as defined in "Appendix Table 9". Variables of interest are in bold

***, **, and * indicate significance at the 1%, 5%, and 10% levels with two-tailed test, respectively

$$AnnCAR\_S_{t+1} = \beta_0 + \beta_1 TaxAggressiveness_t + \beta_2 SizeMVE_t + \beta_3 MTB_t + \varepsilon_{t+1}, \quad (4)$$

where *TaxAggressiveness* represents one of the three measures (*FactorBTD*, *Shelter_W*, and *Shelter_L*). The dependent variable (*AnnCAR_S*) is the sum of quarterly earnings announcement return in 1 year following insider purchase. We obtain similar results if we use mean announcement return.

The estimated results are reported in Panel A of Table 6. The coefficients on all three tax aggressiveness measures are positive and significant, indicating that insider purchases in firms with greater extent of tax aggressiveness are a better predictor of future earnings innovations than trades in other firms. To mitigate endogeniety concerns about tax aggressiveness, we follow a similar procedure discussed in the previous subsection and use 2SLS to estimate Eq. (4). The results in Panel B of Table 6 show that our inferences are robust to controlling for the possible endogeneity of tax aggressiveness. The overall results suggest that insiders from tax aggressive firms are more likely to trade on material future earnings information and gain over the market, which is in support of our hypothesis.

4.3 Tax aggressiveness and trading on bad news

So far we have focused on insider purchases as this type of transactions more likely reflect private information. Insider sales, on the other hand, may take place for liquidity or diversification reasons and thus are not suitable for the test of information rent extraction hypothesis. However, prior studies find that insiders' personal incentives are related to the timing of inside sales (e.g., Yeh et al. 2016). Specifically, insider selling preceding a negative information event is found to be likely motivated by private information. For example, Beneish (1999) and Beneish et al. (2012) find that managers facing deteriorating financial performance and technical defaults manage earnings upward and sell their shares. Ravina and Sapienza (2010) document that both executives and directors earn significant abnormal returns when they sell firm shares before negative news. Milian (2016) documents insider selling prior to imminent bad earnings news through their Rule 10b5-1 trading plans. These studies suggest that managers seem to engage in opportunistic insider sales to take advantage of their private knowledge about firms' negative future performance. To examine whether managers trade on bad news under the cover of aggressive tax practices, we focus on the setting of insider trades preceding bad news.

4.3.1 Tax aggressiveness and the likelihood of trading on bad news

We define bad news as significant drops in earnings as accounting earnings are in the control of management. Following Ravina and Sapienza (2010), we use negative market reactions to earnings announcements to represent earnings drops. A market reaction is treated as negative if the 3-day CAR around earnings announcement date is less than -2% and fell in the bottom quartile of CARs for that specific company. This corresponds to an average drop of -9.97% in CAR surrounding earnings announcement. If an insider trade occurs within 40 days preceding an announcement, we treat it as trading on bad news. There are 5211 trades satisfying the criteria, involving 1046 firms and 1591 executives. The number of trades is small, accounting for only 5.85% of total insider sales, possibly due to the blackout periods and/or the risk of SEC detection and investigation.

To test whether insiders from tax aggressive firms have a higher probability to trade on bad news, we examine whether these insider trades are more likely to take place before bad news. Specifically, we estimate the following logit regression for all insider sales:

$$\begin{aligned} Prob[Bad = 1]_t = {} & \beta_0 + \beta_1 TaxAggressiveness_t \\ & + \beta_2 SizeMVE_{t-1} + \beta_3 MTB_{t-1} + \beta_4 EP_{t-1} \\ & + \beta_5 R\&D_{t-1} + \beta_6 Loss_{t-1} \\ & + \beta_7 FSInformative_{t-1} + \beta_8 PastEarnAnnRet_{t-1} \\ & + \beta_9 Analyst_{t-1} + \beta_{10} Volatility_{t-1} \\ & + \beta_{11} Turnover_{t-1} + \varepsilon_t, \end{aligned} \tag{5}$$

where variable *Bad* takes a value of 1 if a sale trade occurs within 40 days preceding bad news, and 0 otherwise.

As shown in Table 7, the coefficients on all three tax aggressiveness measures are positive and significant at the conventional level, indicating a positive relation between the extent of tax aggressiveness and the likelihood of insider sales before bad news. We obtain similar results with control for the possible endogeneity of tax aggressiveness. One

Table 7 Tax aggressiveness and likelihood of trading on bad news

Variable	Coef.	*P* value	Coef.	*P* value	Coef.	P-value
Panel A: baseline regression						
Intercept	1.009***	26.94	0.935***	23.37	0.929***	23.06
FactorBTD	**0.269****	**5.63**				
Shelter_W			**0.340*****	**41.06**		
Shelter_L					**0.350*****	**42.84**
SizeMVE	−0.033**	4.51	−0.045***	8.20	−0.046***	8.43
PastRet	−0.000***	60.09	−0.000***	56.55	−0.000***	56.82
MTB	−0.007**	6.42	−0.006**	5.84	−0.006**	5.75
EP	0.095***	9.40	0.102***	10.77	0.105***	11.31
R&D	−0.111**	4.93	−0.065	1.70	−0.062	1.54
Loss	−0.422	2.06	−0.378	1.66	−0.379	1.66
FSInformative	0.324***	37.49	0.329***	38.53	0.327***	38.09
Analyst	0.199***	33.30	0.210***	37.09	0.210***	37.08
Volatility	4.277***	9.79	4.653***	11.65	4.706***	11.91
Turnover	−0.251***	121.70	−0.250***	120.41	−0.251***	120.93
N	94,244		94,244		94,244	
R^2	0.27%		0.31%		0.31%	
Panel B: controlling for endogeneity of tax aggressiveness						
Intercept	1.315***	37.63	1.244***	33.24	1.260***	34.44
FactorBTD	**0.536*****	**8.36**				
Shelter_W			**0.778*****	**15.79**		
Shelter_L					**0.774*****	**16.46**
SizeMVE	−0.044**	6.62	−0.074***	15.60	−0.076***	16.18
PastRet	−0.000***	63.86	−0.000***	65.76	−0.000***	65.88
MTB	−0.000	0.00	0.002	0.47	0.002	0.54
EP	0.108***	10.25	0.117***	11.86	0.117***	11.99
R&D	−0.185***	12.07	−0.167***	9.72	−0.165***	9.52
Loss	−0.899***	7.85	−0.942***	8.56	−0.946***	8.62
FSInformative	0.220***	14.44	0.212***	13.41	0.212***	13.32
Analyst	0.156***	17.43	0.153***	16.54	0.152***	16.47
Volatility	−0.097	0.00	−0.012	0.00	−0.016	0.00
Turnover	−0.243***	94.43	−0.242***	93.22	−0.242***	93.04
N	79,152		79,152		79,152	
R^2	0.29%		0.30%		0.30%	

Table 7 (continued)

This table presents results testing whether tax aggressiveness is related to the likelihood of insiders trading on bad news. The initial sample includes 89,096 insider sale transactions over the period 1992–2017. Bad news is defined as a significant drop in earnings represented by negative market reaction to earnings announcements. A market reaction is treated as negative if the 3-day cumulative abnormal returns (CARs) around the earnings announcement date are less than −2% and fell in the bottom quartile of the CARs for that specific company. Panel A reports results from the baseline regression and Panel B reports the second stage regression results from the two-stage least squares approach to control for the endogeneity of tax aggressiveness. The baseline regression model is as follows:

$$\begin{aligned} Prob(Bad)_t = {} & \beta_0 + \beta_1 TaxAggressiveness_t \\ & + \beta_2 SizeMVE_{t-1} + \beta_3 MTB_{t-1} + \beta_4 EP_{t-1} \\ & + \beta_5 R\&D_{t-1} + \beta_6 Loss_{t-1} \\ & + \beta_7 FSInformative_{t-1} + \beta_8 PastEarnAnnRet_{t-1} \\ & + \beta_9 Analyst_{t-1} + \beta_{10} Volatility_{t-1} \\ & + \beta_{11} Turnover_{t-1} + \varepsilon_t, \end{aligned}$$

where *Bad* equals 1 if a trade occurs within 40 days preceding bad news and 0 otherwise. *TaxAggressiveness* is one of the three tax aggressiveness measures (*FactorBTD, Shelter_W, and Shelter_L*). Variables are as defined in "Appendix Table 9". Variables of interest are in bold

***, **, and * indicate significance at the 1%, 5%, and 10% levels with two-tailed test, respectively

potential concern with our estimated results from Eq. (5) is that tax aggressive firms are more likely to suffer from significant earnings drops, which mechanically causes a higher chance for managers to trade during this period. If this is the case, we should be able to observe a similar phenomenon for insider purchase transactions. However, when we estimate Eq. (5) for all insider purchases (there are 639 purchases before bad news), the coefficients on the two tax shelter measures are not significant. The evidence suggests that the higher likelihood of insider sales preceding significant earnings drops by insiders at tax-aggressive firms is due to these insiders trading on bad news.

4.3.2 Tax aggressiveness and insider trading profits on bad news

We then analyze how trading profits from insider sales preceding bad news are related to tax aggressiveness by estimating Eq. (2) for these trades and report the results in Table 8. As shown in Panel A, the coefficients on the two tax shelter measures are positive and significant and the coefficient on *FactorBTD* is positive but insignificant. However, after controlling for the endogeneity of tax aggressiveness, the coefficients on all three tax aggressiveness measures are positive and significant (reported in Panel B), suggesting that insiders gain more from trading on bad news with the camouflage of tax avoidance.

4.3.3 Alternative definition of bad news

An alternative approach to define bad news is to use significant drops in stock price. However, there are two drawbacks in using stock price drops. First, stock price drops can be triggered by uncontrollable events and thus may not be predicted and traded on by managers. Second, some price drops may have been caused by the herding effect, i.e., when insiders sell the market interprets it as a bad signal about firm prospects (Ravina and Sapienza 2010). We treat a daily market-adjusted return of less than -8% and the return falling in the bottom 10% of returns for all CRSP firms as significant stock price drops. Similar to

Table 8 Tax aggressiveness and insider trading profits: bad news

Variable	Coef.	t-stat.	Coef.	t-stat.	Coef.	t-stat.
Panel A: baseline regression						
Intercept	−0.362***	−8.74	−0.362***	−8.96	−0.347***	−8.68
FactorBTD	**0.066**	**1.55**				
Shelter_W			**0.027****	**2.55**		
Shelter_L					**0.000***	**1.83**
SizeMVE	0.008***	2.77	0.007**	2.35	0.008**	2.55
PastRet	0.000	1.43	0.000*	1.66	0.000	1.60
MTB	−0.001**	−2.35	−0.001**	−2.38	−0.001**	−2.33
EP	−0.001	−0.16	−0.000	−0.07	−0.001	−0.21
R&D	0.037***	3.24	0.037***	3.32	0.034***	3.13
Loss	−0.030	−0.43	−0.015	−0.21	−0.013	−0.18
FSInformative	0.087***	8.16	0.089***	8.26	0.089***	8.25
PastEarnAnnRet	0.305**	2.37	0.333***	2.64	0.348***	2.77
Analyst	0.017**	2.55	0.019***	2.86	0.018***	2.74
Volatility	0.218	0.64	0.228	0.66	0.170	0.50
Turnover	−0.026***	−5.36	−0.027***	−5.44	−0.026***	−5.35
N	5211		5211		5211	
R^2	3.07%		3.08%		3.02%	
Panel B: controlling for endogeneity of tax aggressiveness						
Intercept	−0.371***	−8.31	−0.368***	−8.28	−0.366***	−8.27
FactorBTD	**0.170*****	**3.12**				
Shelter_W			**0.130*****	**3.21**		
Shelter_L					**0.130*****	**3.26**
SizeMVE	0.008**	2.32	0.003	0.83	0.003	0.73
PastRet	0.000	1.28	0.000	1.19	0.000	1.17
MTB	−0.001	−1.49	−0.001	−1.22	−0.001	−1.17
EP	0.061	0.80	0.067	0.87	0.067	0.87
R&D	0.001	0.10	0.000	0.01	0.000	0.02
Loss	0.052***	4.36	0.052***	4.35	0.052***	4.37
FSInformative	0.096***	8.13	0.096***	8.15	0.095***	8.13
PastEarnAnnRet	0.233*	1.68	0.242*	1.75	0.240*	1.73
Analyst	0.016**	2.17	0.016**	2.23	0.016**	2.23
Volatility	0.126	0.35	0.081	0.22	0.083	0.23
Turnover	−0.022***	−4.13	−0.022***	−4.14	−0.022***	−4.13
N	4484		4484		4484	
R^2	3.75%		3.72%		3.74	

This table presents results testing whether tax aggressiveness is related to insiders' trading profits on bad news. The sample includes 5211 insider sale transactions occurring within 40 days preceding a significant drop in earnings represented by negative market reactions to earnings announcements. A market reaction is treated as negative if the 3-day cumulative abnormal returns (CARs) around the earnings announcement date are less than -2% and fell in the bottom quartile of the CARs for that specific company. Panel A reports results from the baseline regression and Panel B reports the second stage regression results from the two-

Table 8 (continued)

stage least squares approach to control for the endogeneity of tax aggressiveness. The baseline regression model is as follows:

$$\begin{aligned} DailyRet\,(180)_t = {} & \beta_0 + \beta_1 TaxAggressiveness_t \\ & + \beta_2 SizeMVE_{t-1} + \beta_3 PastRet_{t-1} \\ & + \beta_4 MTB_{t-1} + \beta_5 EP_{t-1} + \beta_6 R\&D_{t-1} \\ & + \beta_7 Loss_{t-1} + \beta_8 FSInformative_{t-1} \\ & + \beta_9 PastEarnAnnRet_{t-1} + \beta_{10} Analyst_{t-1} \\ & + \beta_{11} Volatility_{t-1} + \beta_{12} Turnover_{t-1} + \varepsilon_t, \end{aligned}$$

where *TaxAggressiveness* is one of the three tax aggressiveness measures (*FactorBTD, Shelter_W, and Shelter_L*). Variables are as defined in "Appendix Table 9". Variables of interest are in bold

***, **, and * indicate significance at the 1%, 5%, and 10% levels with two-tailed test, respectively

Ravina and Sapienza (2010), we analyze insider trades initiated within the 120 days preceding bad news. There are 38,225 trades satisfying the criteria, including 30,756 sales and 7469 purchases.

Corroborating our previous results, we find positive and significant coefficients on all three tax aggressiveness measures when we replicate Eq. (5) by setting variable *Bad* to 1 if insider selling occurs within the 120 days preceding significant stock price drops, and 0 otherwise. To mitigate concerns that the higher likelihood of insider selling preceding significant stock price drops by insiders from tax aggressive firms is a mechanical result of the higher likelihood of stock price crashes associated with tax aggressiveness (Kim et al. 2011), we investigate insider selling intensity preceding bad news by estimating a regression similar to Eq. (2) but with net selling (the number of shares sold over common shares outstanding, and net purchase is treated as negative sale) as the dependent variable. If the higher chance of sale is due to managers' trading on bad news, we should be able to observe a higher selling intensity for tax aggressive firms. Consistent with insiders trading on bad news, the untabulated results show that managers from firms with higher probability of engaging in tax shelters sell more shares in anticipation of bad news.

5 Sensitivity analyses

5.1 Controlling for insider heterogeneity

It is possible that heterogeneity of insiders, such as insiders' ability, preference or style, affects both aggressive tax avoidance and informed trading, which may lead to the positive relation between tax aggressiveness and insider trading profits. To test this alternative explanation, we first control for managerial ability using the measure developed by Demerjian et al. (2012). Untabulated results show that across all three tax measures, the coefficient on managerial ability is positive and significant, suggesting more capable managers gain more from insider trades. Most importantly, the positive relation between tax aggressiveness and insider trading profits remain unchanged with the control of managerial ability.

Then we run individual-level fixed effects to address the effect of unobservable styles. After requiring insiders to have at least two transactions to run individual-level fixed effects, we are left with 14,602 observations. We replicate Eq. (2) with this sample and the coefficient on *FactorBTD*, *Shelter_W*, and *Shelter_L* is 0.176 (t = 3.66), 0.099 (t = 6.59), and 0.100

(t = 6.62), respectively. However, when we re-estimate Eq. (2) with individual-level fixed effects, the corresponding coefficient is 0.100 (t = 3.87), 0.084 (t = 7.01), and 0.086 (t = 7.10), respectively. It seems that the contribution of insider unobservable characteristics to the positive association between tax aggressiveness and insider trading profits is moderate.

5.2 Controlling for omitted variable bias

In our baseline regression model, we mostly follow prior studies on insider trading and include control variables related to information asymmetry, past stock performance, and firm size. It is possible that some other factors may affect both insider trading profits and aggressive tax planning activities (e.g., Jia et al. 2020). One such factor is corporate governance. If poor governance structures allow managers to engage in aggressive tax avoidance and informed insider trading, it could be that corporate governance structure of a firm is driving our results. We conduct robustness tests controlling for corporate governance to help rule out this alternative explanation. Specifically, we control for the percentage of shares held by institutional owners and the Bebchuk et al.'s (2009). E-Index, an entrenchment index based on six provisions (poison pills, golden parachutes, staggered boards, limits to shareholder bylaw amendments, supermajority requirements for mergers, supermajority requirements for charter amendments). Untabulated results show the coefficients on institutional ownership are negative and significant and the coefficients on E-Index is positive but insignificant, providing some evidence that governance mechanisms limit insiders' ability to extract information rents. More importantly, the coefficients on the tax aggressiveness measures remain unchanged in terms of direction, significance, and magnitude. In addition to simply controlling for governance effects, we further explore whether the relation between insider trading profits and tax aggressiveness is sensitive to the strength of firm-level governance. We interact governance variables with each of the three tax aggressiveness measures and find the coefficients on the three interaction terms are not significant when the governance measure is E-Index and the coefficients on the two interaction terms with the tax shelter measures are negative and significant when the governance measure is institutional ownership. On one hand, these findings are consistent with prior evidence that corporate governance play a limited role in moderating the relation between executive equity incentives and tax avoidance (Rego and Wilson 2012) and that between tax avoidance and accounting fraud (Lennox et al. 2013). On the other hand, these findings suggest that institutional shareholders can constraint insiders' ability to extract informational rent using tax shelter strategies.

To the extent that executive equity risk incentives motivate risky tax avoidance practices, leading to an increase in cash flow volatility (Rego and Wilson 2012), which could affect insider trading profits, equity risk incentives may represent another correlated omitted variable. We measure equity risk incentives as stock options *vega* (the change in stock options portfolios with a 1% change in stock price volatility). Untabulated results show that while *vega* is positively related to insider trading profits, the coefficients on the tax shelter measures remain positive and significant after controlling for the effect of executive risk-taking incentives.

Prior studies on insider trading provide evidence that accruals management is associated with subsequent opportunistic insider trading (Beneish and Vargus 2002; Bartov and Mohanram 2004). The literature on tax avoidance also finds that accruals management is connected to tax avoidance (Frank et al. 2009). To test whether our measures of tax aggressiveness pick up the effect of accruals management, we replicate Eq. (2) with the inclusion

of performance-adjusted absolute accruals (*ADAccrual*) estimated following the procedure of Kothari et al. (2005). While insiders gain more in firms with high level of abnormal accruals, we still find positive and significant coefficients on tax aggressiveness measures after controlling for quality of accruals.

Even though we include an array of variables to control for potentially correlated factors, we still cannot eliminate the possible bias caused by omitted variables, such as corporate culture. To mitigate this concern, we estimate Eq. (2) using firm-fixed effects to abstract from time-invariant factors and our inferences remain robust to firm-fixed effects.

5.3 Alternative measures

Our last battery of robustness checks involve testing whether our results are sensitive to alternative measures of tax avoidance and trading profits. We first use individual BTD measures: total BTD (*TBTD*), permanent BTD, and discretionary permanent BTD and find that the coefficients on all these individual measures are positive and significant. We also note that our inferences remain unchanged if we use different event windows or buy-and-hold returns to measure trading profits.[5]

6 Conclusions

Embedding tax avoidance decisions within an agency framework broadens our understanding of corporate tax avoidance activities. However, there is very limited empirical evidence confirming that aggressive tax avoidance serves managerial rent extraction. The lack of systematic evidence casts serious doubts on the validity of agency explanation. To shed light on this important research question, we employ insider trading as a powerful setting to examine the relation between aggressive tax avoidance and managerial rent extraction. Informed insider trading has unambiguous impact on executives' personal wealth and represents the most direct channel through which managers extract rents from uninformed shareholders.

Using three tax avoidance measures to capture aggressive tax practices in tests on a large sample of insider purchase transactions, we find that insiders at firms with greater tax aggressiveness gain significantly higher trading profits than insiders at firms with less tax aggressiveness. Our further analyses suggest that the insider outperformance results from trading on future earnings news. In addition to gaining more from trading on good news via purchase transactions, insiders, under the cover of aggressive tax practices, are more likely to trade on bad news via insider sales and gain from these trades. The overall evidence is consistent with our hypothesis that aggressive tax avoidance serves managerial interests in gainfully exploiting private information and extracting rents from uninformed shareholders.

Appendix

See Table 9.

[5] In 1993, FAS 109, Accounting for Income Taxes, was enacted and the statutory corporate income tax rate increased from 34 to 35%. To ensure that regulatory events regarding income taxes around 1993 do not affect our results, we replicate our analyses using the sample from 1995 to 2017 and obtain similar results.

Table 9 Variable definition

Variable	Definition
Measures of tax avoidance	
TBTD	Frank et al. (2009) total book-tax difference calculated as (pre-tax income − (current federal tax expense + current foreign tax expense)/Statutory tax rate)/lagged assets = (PI − (TXFED + TXFO)/Statutory tax rate)/AT_{t-1}. If current federal tax expense (TXFED) is missing, then we calculate it as total tax expense − deferred tax expense − state tax expense, − foreign tax expense = TXT − TXDI − TXS − TXFO. If information for TXFO or TXS is missing, we set the value of each of them to zero
PermDiff	Frank et al. (2009) permanent book-tax difference calculated as (total book-tax difference − temporary book-tax difference)/lagged assets = (PI − (TXFED + TXFO)/Statutory tax rate − TXDI/Statutory tax rate)/AT_{t-1}. If current federal tax expense (TXFED) is missing, then we calculate it as total tax expense − deferred tax expense − state tax expense, − foreign tax expense = TXT − TXDI − TXS − TXFO. If information for TXFO or TXS is missing, we set the value of each of them to zero
DTAX	Frank et al. (2009) discretionary permanent book-tax difference calculated as the residual from the following regression estimated by 2-digit SIC code and fiscal year: $PermDiff_t = \beta 0 + \beta 1\, INTANG_t + \beta 2\, UNCON_t + \beta 3\, MI_t + \beta 4\, CSTE_t + \beta 5\, \Delta NOL_t + \beta 6\, PermDiff_{t-1} + \varepsilon_t$, where $INTANG_t$ = goodwill and other intangibles (INTAN) scaled by total assets (AT_{t-1}); $UNCON_t$ = income (loss) reported under the equity method (ESUB) scaled by total assets (AT_{t-1}); MI_t = income (loss) attributable to minority interest (MII) scaled by total assets (AT_{t-1}); $CSTE_t$ = current state income tax expense (TXS) scaled by total assets (AT_{t-1}); and ΔNOL_t = change in net operating loss carryforwards (TLCF) scaled by total assets (AT_{t-1}) If information for MII, TXFO, ESUB, or TXS is missing, then we set the value of each of them to zero. If information for INTANG is missing, then we set its value to 0. If INTANG = "C", then we set the value of INTANG to that for goodwill (GDWL)
FactorBTD	A common factor extracted from three book-tax difference measures: TBTD, PermDiff, and DTAX
Shelter_W	Wilson's (2009) estimated tax sheltering probability computed as the predicted value of the following regression model (Table 5 Column 3 in Wilson (2009): $SHELTER\_PW_t = -4.86 + 5.20 \times BTD_t + 4.08 \times DAccrual_t - 0.41 \times Leverage_t + 0.76 \times SizeAT_t + 3.51 \times ROA_t + 1.72 \times FIncome_t + 2.43 \times RDA_t$, where BTD_t = book- tax difference defined as defined by Kim et al. (2011); $DAccrual_t$ = discretionary accruals from the performance-adjusted modified cross-sectional Jones Model; $Leverage_t$ = firm leverage defined as long-term debt ($DLTT_t$) divided by total assets (AT_{t-1}); $SizeAT_t$ = the log of total assets in year *t*; ROA_t = return on assets (PI_t/AT_{t-1}); $FINCOME_t$ = foreign pre-tax income ($PIFO_t$) divided by total assets (AT_{t-1}); RDA_t = research and development expense (XRD) divided by total assets (AT_{t-1}) $SHELTER\_PW_t$ is ranked into percentiles each year and then scaled by 100 to make the value between (0 1) We refer to this variable as Shelter_W

Table 9 (continued)

Variable	Definition
Shelter_L	Lisowsky's (2010) estimated tax sheltering probability computed as the predicted value of the following regression model (Table 4 Column 2 in Lisowsky (2010): $SHELTER\_PL_t = -43.47 + 0.756 \times BTD_t + 0.748 \times DAccrual_t - 1.036 \times Leverage_t + 0.70 \times SizeAT_t + 3.196 \times ROA_t + 17.305 \times FIncome_t + 4.391 \times RDA_t$, where BTD_t = book-tax difference defined as defined by Kim et al. (2011); $DAccrual_t$ = discretionary accruals from the performance-adjusted modified cross-sectional Jones Model; $Leverage_t$ = firm leverage defined as long-term debt ($DLTT_t$) divided by total assets (AT_{t-1}); $SizeAT_t$ = the log of total assets in year t; ROA_t = return on assets (PI_t/AT_{t-1}); $FINCOME_t$ = foreign pre-tax income ($PIFO_t$) divided by total assets (AT_{t-1}); RDA_t = research and development expense (XRD) divided by total assets (AT_{t-1}) $SHELTER\_PL_t$ is ranked into percentiles each year and then scaled by 100 to make the value between (0 1) We refer to this variable as Shelter_L
Measures of insider trading	
DailyRet (180)	Abnormal trading profits estimated as the intercept (or alpha) of the following model over the 180 days following each transaction:$Ri-Rf = \alpha + \beta 1(Rmkt-Rf) + \beta 2\ SMB + \beta 3\ HML + \beta 4\ UMD + \varepsilon$, where Ri = firm i's daily stock return; Rf = the daily risk-free interest rate; $Rmkt$ = the CRSP value-weighted market return; SMB, HML, and UMD = the size, book-to-market, and momentum factors (Fama and French 1993; Carhart 1997); α (−α) is the average daily risk-adjusted return to a net purchase (sale), expressed as percentage
BHR (180)	Buy-and-hold market adjusted abnormal return over the 180 days following each transaction
AnnCAR_M	Mean three-day cumulative abnormal returns (− 1 1) around the quarterly earnings announcement for all quarters in 1 year following each purchase
AnnCAR_S	Summation of three-day cumulative abnormal returns (− 1 1) around the quarterly earnings announcement for all quarters in 1 year following each purchase
Control variables for baseline regression	
SizeMVE	The natural logarithm of market value of equity (PRCC_F * CSHO)
PastRet	Market-adjusted returns over the interval (− 380, − 20) before each trade
MTB	Market value of equity (PRCC_F * CSHO) divided by book value of equity (CEQ)
EP	Earnings before extraordinary items (IB) divided by market value of equity 20 days before the trade
R&D	An indicator variable equal to 1 if there is positive R&D expenses (XRD), and 0 otherwise
LOSS	An indicator variable equal to 1 if earnings (IB) are negative, and 0 if earnings are positive
FSInformative	The adjusted R^2 from a firm-specific time-series regression of price per share on book value and earnings per share using quarterly data over a 20-quarter period ending with the fourth quarter of fiscal year t
PastEarnAnnRet	The median cumulative abnormal returns around the quarterly earnings announcements over the past 5 years
Analyst	The natural logarithm of the number of analysts following the firm

Table 9 (continued)

Variable	Definition
Volatility	The standard deviation of daily stock returns over the interval of (−380, −20) prior to each trade
Turnover	The average ratio of daily trading volume over share outstanding over the interval of (−380, −20) before each trade
Determinants of tax aggressiveness	
ADAccrual	Absolute value of discretionary accruals, where discretionary accruals are computed using the modified Jones model including lagged ROA as an additional regressor
ROA	Return on assets estimated as operating income ($PI_t - XI_t$) divided by lagged total assets (AT_{t-1})
NOL	An indicator variable coded as 1 if loss carryforward (TLCF) is positive and 0 otherwise
ChgNOL	Chang in loss carryforward (TLCF) divided by lagged total assets (AT_{t-1})
Leverage	Leverage ratio calculated as long-term debt (DLTT) divided by lagged total assets (AT_{t-1})
Cash	Cash ratio calculated as cash and cash equivalent (CHE) divided by lagged total assets (AT_{t-1}).
FIncome	Foreign operating income (PIFO) divided by lagged total assets (AT_{t-1}). Missing values for PIFO are set to zero
SGrowth	Sales growth ($SALE_t - SALE_{t-1}$)/$SALE_{t-1}$
PPE	Property, plant and equipment (PPENT) divided by lagged assets (AT_{t-1})
INTANG	Intangible assets (INTAN) divided by lagged assets (AT_{t-1})
EQINC	Equity income in earnings (ESUB) divided by lagged assets (AT_{t-1})

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