Corporate Tax Avoidance and Stock Price Informativeness

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Abstract

We show that private information incorporated by outside investors into stock price has an economically significant effect on the sensitivity of corporate tax avoidance to stock price. Corporate tax avoidance is much more sensitive to stock price when the price contains new information to managers. This effect is robust to the inclusion of controls for various sources of public and managerial private information and is stronger in firms with higher capital intensity and foreign operations. Overall, the results suggest that managers learn from the private information in stock prices and incorporate this information into their corporate tax avoidance decisions.

JEL classification: G14; G31; G32

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1. Introduction

Do managers learn from stock markets when avoiding corporate taxes? There is ample evidence that corporate income tax structure affects investment decisions and that managers learn from their stock prices. However, the relation between managerial learning from prices and corporate tax avoidance decisions has been relatively underexplored. Hall and Jorgenson (1967) were the first to show that firms alter their investment behavior depending on tax policies. Firms may invest in a tax-preferred asset that provides a higher after-tax return even if the pre-tax return of this asset is lower than that of a fully taxed asset of identical risk (Scholes and Wolfson 1992).[1] Firms also avoid taxes to obtain cash savings, especially valuable when firms are financially constrained and future financing is not frictionless (Gamba and Triantis 2008; Riddick and Whited 2009; Graham et al. 2017).

We posit that a firm's corporate tax avoidance strategies are implemented in conjunction with its policies on corporate investment and cash holdings. Previous studies show that managers learn external information from their stock price and incorporate this information to their decisions on corporate investments and cash savings (Chen et al. 2007; Fresard 2012).[2] Stock prices aggregate diverse pieces of information through the trading activity of many different investors. As a result, stock prices may contain private information that managers do not possess. Market prices may, for example, contain specific information about firm fundamentals such as the firm's growth prospects and future external financing costs, the firm's reputation in capital and product

[1] Hanlon and Heitzman (2010) provide an excellent review of tax research. For a more recent review of this literature, see Wang et al. (2020). Several studies examine the effect of taxes on investment location decision, foreign direct investment, and corporate mergers and acquisition decisions (Maydew 2001; Cloyd et al. 2003; Shackelford et al. 2011; Djankov et al. 2010; and Graham et al. 2014).

[2] Durnev, Morck, and Yeung (2004) find that firms' capital investments are more efficient and value-enhancing when stock price is more informative. Luo (2005) shows that that merging firms extract information from stock prices. Bakke and Whited (2010) confirm that managers incorporate private investor information when making investment decisions. Mathers et al (2017) find that firms' innovation outcomes improve with price informativeness.

markets, and other strategic issues involving the firm's relationship with various stakeholders.[3] To the extent that stock prices convey useful new information to managers, this information will also guide managers' decisions on tax avoidance together with other corporate decisions and therefore, affect the sensitivity of firms' tax avoidance to the stock price.

Tax-avoiding firms engage in activities that, in general, represent a continuum of tax planning strategies from investing in municipal bonds to sheltering taxes through investing in projects with tax credits or operating in international tax havens (Hanlon and Heitzman 2010). These firms provide necessary incentives for managers to obtain technical skills and expertise in tax planning such as hiring tax directors or external auditors to reduce the level of corporate tax expenses (Armstrong et al. 2012; Huseynov and Klamm 2012). Additionally, institutional investors such as hedge funds can provide such expertise to firm managers to increase the value-efficiency of tax avoidance (Cheng et al. 2012). These investors may also introduce incentive mechanisms for managers to avoid more taxes to increase firm value. For example, Khan et al. (2017) show that institutional investors are unlikely to "explicitly" promote tax avoidance, but managers "deliver" tax avoidance when institutional ownership increases. However, these efforts may not be sufficient to equip managers with all the necessary tools to avoid taxes optimally. Stock prices may reflect new information that is not readily available for managers. The nature of this incremental new information to managers may be diverse and relevant to corporate tax avoidance for several reasons.

First, avoiding corporate taxes entails making specific investment decisions. According to the "economic substance doctrine" in tax law, the tax strategy must have a valid business purpose

[3] Dow and Gorton (1997) and Subrahmanyam and Titman (1999) theoretically show that managers can use the information they infer from their stock prices to improve the efficiency of their corporate decisions and thus enhance the value of their firm. See also Dye and Sridhar (2002) and Goldstein and Guembel (2008).

and economic substance other than financial accounting benefits that arise solely from tax savings (Scholes et al. 2014). In Graham et al. (2014), which surveys corporate tax executives, 86 percent of respondents state that the most important reason for not implementing a tax strategy is because the transaction lacked business purpose or economic substance. Stock prices may contain specific information that may help managers to assess the economic substance of their tax-preferred investment decisions. By learning this information, managers can reduce the probability of facing challenges and potential denial of future tax benefits by the IRS.

Second, one reason why firms engage in less tax avoidance is related to concerns regarding agency issues and reputational matters. Firms are concerned that engaging in tax avoidance is potentially harmful to firm reputation and may lead to negative publicity and backlash by stakeholders (Huseynov and Klamm 2012; Graham et al. 2014). While Gallemore et al. (2014) do not find evidence that reputation significantly influences the likelihood of tax shelter usage, Khurana and Moser (2013) show that firms with long-term institutional shareholders engage in less tax avoidance, especially if such activities encourage managerial opportunism and reduce transparency. It is possible that managers obtain some relevant information from the markets prior to avoiding taxes and do not engage in tax avoidance to the extent that it would exacerbate agency costs or harm the firm's reputation. We consider this possibility given the increased public scrutiny, at least, over the question whether large firms pay their fair share of taxes.

Third, firms avoid taxes to achieve financial flexibility through tax savings. Prior literature shows that one of the reasons for cash hoarding is to finance future investment projects in the presence of capital market frictions (Almeida et al. 2004; Acharya et al. 2007). The value of cash holdings increases especially when firms are financially constrained and future external financing is uncertain (Gamba and Triantis 2008; Denis and Sibilkov 2010; Fresard 2012). Investing in tax-

efficient assets enables a firm to funnel some of the cash tax savings into liquid assets that can later be turned into physical investments. Therefore, if prices are more informative about the productivity of future investments when future financing is not frictionless, , managers will adjust their propensity to obtain cash savings through corporate tax avoidance based on the information they learn from market prices.

Therefore, we argue that a firm's decision to avoid corporate taxes is intertwined with the firm's investment policies, motivations to save cash, and managers' assessment of potential direct and indirect costs of tax avoidance. To the extent that managers can learn from stock prices necessary information about future strategic issues, including stakeholders' perception of tax avoidance, managerial learning from stock prices should also determine the manager's propensity to engage in corporate tax avoidance.

We follow the methodology of Chen et al. (2007) and Fresard (2012) and examine how the informativeness of stock prices affects the sensitivity of tax avoidance to stock price. According to the learning hypothesis, when managers decide on the optimal level of corporate tax avoidance, they will use all the information available to them. This includes both the information aggregated in the stock price and managers' private information that has not yet been incorporated into the price. Managers are more likely to learn from stock prices when the price conveys more investors' private information new to managers. Therefore, tax avoidance should be more sensitive to stock price when it contains a larger fraction of investors' private information.

We start our analysis of the empirical relation between price informativeness and corporate tax avoidance in a panel regression framework with firm fixed effects and year fixed effects. Using firm fixed effects addresses potential endogeneity concerns that may arise due to unobservable time-invariant firm characteristics (omitted variables) which could affect both stock price

informativeness and tax avoidance behavior. We use a large sample of U.S. firms over the period 1970-2018. Following the prior literature (Dyreng et al. 2008; Koester et al. 2017), we use both short-term and long-term cash effective tax rate (Cash ETR) as our main variables of corporate tax avoidance. Note that lower Cash ETR levels indicate more corporate tax avoidance. We also use the method by Wilson (2009) to identify firms that are likely to engage in tax sheltering. While lower Cash ETR may be associated with greater tax planning motivations, tax sheltering reflects more aggressive tax avoidance strategies. Following prior literature, we use stock price nonsynchronicity as the measure of price informativeness.[4]

In the first set of results, we find that corporate tax avoidance is positively and significantly associated with stock price, as measured by Tobin's Q. This suggests that firms actively incorporate information from stock prices into their tax avoidance strategies. Furthermore, firms tend to avoid taxes more when stock price contains a greater amount of private information from investors. We show that the price informativeness measure has a significantly positive effect on the price sensitivity of tax avoidance (lower Cash ETRs and a greater likelihood of tax sheltering). This result suggests that stock prices reflecting greater private information transmit useful new information to managers and affect their tax avoidance behavior. Managers learn from this private information and choose to engage in greater tax avoidance.

We recognize in our empirical analysis that unobservable omitted factors (that vary over time) might affect both stock price informativeness and corporate tax avoidance decisions. It is also conceivable that a firm's tax avoidance behavior may obscure the information content of its

[4] This measure was first developed by Roll (1988) to capture stock return variation that is not explained by market and industry fluctuations. Several studies have used this measure and related stock price informativeness to corporate investment decisions (Durnev et al 2003, 2004; Chen et al. 2007; Mathers et al. 2017). Our findings are consistent when we use the probability of informed trading (PIN) measure developed by Easley, Hvidkjaer, O'Hara (2002). We also use a set of other variables, including managerial ability, firm size, leverage, return on assets, operating income, discretionary accruals, analyst coverage, and institutional ownership to control for other factors that may impact firm's propensity to avoid corporate taxes.

stock price and change the level of private information reflected in the stock price, indicating reverse causality. We use an instrumental variable (IV) approach with two-stage least squares (2SLS) method to further mitigate these potential endogeneity concerns. Employed two instruments for price informativeness are Autoquote introduction to NYSE listed firms (following Hendershott et al. 2011) and firm's inclusion within the S&P 500 Index (Mathers et al. 2017). The introduction of Autoquote, which exogenously increases algorithm trading, should directly affect the informativeness in stock prices (Hendershott et al. 2011). Additionally, Wurgler (2010) finds that stock returns of newly added S&P 500 firms become more correlated with other firms in the index and less correlated with the rest of the market, causing their prices to become less reflective of firm-specific information. Our IV analysis results are consistent with the hypothesis that managers use the private information reflected in the stock price when they make decisions to avoid corporate taxes.

One potential concern is that firm managers may already possess sufficient information about the future benefits and costs of tax avoidance and the information embedded in stock price may not be new to managers. Therefore, we conduct several tests to confirm the robustness of the managerial learning channel. Because the information available to managers is difficult to observe, we use several variables to disentangle managerial information from new information embedded in prices. First, we investigate the role of managers with greater ability to allocate resources. Koester et al. (2017) show that managers with superior ability avoid corporate taxes more. We use the managerial ability measure developed by Demerjian et al. (2012) in our analysis. We find that the impact of prices on corporate tax avoidance is lower in firms with higher managerial ability. A negative impact is expected because managers who are better at allocating corporate resources possess more information and rely less on the information in stock prices for their tax avoidance

decisions. More importantly, we find that the effect of stock price informativeness on the sensitivity of corporate tax avoidance to price is still positive even after controlling for managerial ability. Thus, tax avoidance is more sensitive to stock price when the price contains a larger amount of private information in firms with lower managerial ability.

Second, to examine the effect of private information in price that is not otherwise available to managers on the sensitivity of corporate tax avoidance to price, we control for the stock's overall liquidity and the degree of public information in the equity market. We use the bid-ask spread as a measure of both the market liquidity of the stock and the extent of public information reflected in stock price. We also use analyst coverage as an alternative measure of public information. Financial analysts mostly serve as information conduits between firms and investors, so that their presence implies less new information conveyed in stock price to managers. We find that, after controlling for bid-ask spread and analyst coverage, private information in stock price that is new to managers is still positively associated with the sensitivity of tax avoidance to price. Furthermore, we sort the full sample into quintiles based on private information and run the model separately for each quintile-based subsample. We find that the sensitivity of tax avoidance to price is stronger with higher levels of private information. These results suggest that managers learn more regarding their tax avoidance activities when there is more private information contained in the market price.

We also conduct several other cross-sectional tests to consider the role of financial constraints, external governance, capital intensity, and foreign operations. Our findings suggest that current financial constraints weaken the effect of private information on the sensitivity of tax avoidance to price. We interpret this as evidence that current financial constraints may impose some restrictions on managerial propensity to avoid taxes and supersede the effect of managerial learning from stock prices. This is consistent with Bayar et al. (2018) that greater tax avoidance

may further exacerbate financial constraints. Additionally, we confirm that our results are not affected by the level of institutional ownership. Finally, we find that the positive sensitivity of corporate tax avoidance to price informativeness is greater in magnitude for firms with higher capital intensity and for firms with foreign operations. These findings are consistent with the observation that firms with greater capital intensity and global operations have a larger number of tax avoidance tools available to them. In addition, learning private information from stock prices may be more valuable for these firms given their need to guide themselves when making global capital investment decisions.

Our paper contributes to the literature in three important ways. First, we document that managers learn from stock prices when making decisions related to corporate taxes. This is a new channel through which stock prices affect managerial actions and to our knowledge, ours is the first study to link corporate tax avoidance to price informativeness. Our findings also show that managers may improve the value efficiency of their tax avoidance decisions based on the feedback they receive from stock market investors through the stock price.

Second, the prior literature on corporate tax avoidance links managerial decisions regarding taxes to various factors, such as managerial incentives, ownership structure, financial constraints, and firm-specific factors. We focus on the informational role played by stock prices and show that one of the driving factors behind corporate tax avoidance is managerial learning from the information embedded in stock prices. In addition, there is a longstanding debate on why firms "under-avoid" taxes (Weisbach 2001; Desai and Dharmapala 2006; Hanlon and Heitzman 2010; Gallemore et al. 2014). Our results show that managerial decisions to avoid taxes are related to information managers glean from stock markets. It is possible that the information that is

received by the managers of under-avoiding firms do not clearly convey the value efficiency of tax avoidance, hence curbing their propensity to avoid taxes.

We also contribute to the literature that analyzes how stock prices affect corporate decisions (e.g., Barro 1990; Morck et al. 1990). The paper is related to the growing empirical literature on managerial learning channels: the role of private information in stock prices (e.g., Chen et al. 2007), the informativeness of peers' stock prices (e.g., Foucault and Fresard 2014; Dessaint et al. 2019), firms' capital constraints (e.g., Baker et al. 2003) in driving the investment-to-price sensitivity of firms. We contribute to these studies by showing that stock prices produce new information to managers and increase the efficiency of corporate tax avoidance decisions.

The rest of the paper is organized as follows. Section 2 presents the empirical methodology and describes the sample and the variables. Section 3 discusses the empirical results of baseline tests as well as those of additional tests. Section 4 presents the results of heterogeneity tests. Finally, Section 5 presents the conclusion.

2. Data and Variables

The data used in this study are aggregated from several sources. We draw firms' financial characteristics from Compustat and stock price information from CRSP. The institutional ownership data is acquired from Thomson Reuters 13F Institutional Holdings and the analyst coverage data is available from I/B/E/S. Following the prior tax planning literature, firm-year observations with missing total assets and those with missing or non-positive pretax income are dropped. We also eliminate financial firms and utility firms (SIC codes 4000-4999 and 6000-6999). Our sample consists of 43,501 firm-year observations for US publicly listed firms from 1970 to 2018.

2.1 Tax Avoidance Measures

Our measure of tax management is the cash effective tax rate (*Cash ETR*), calculated by cash paid for income taxes scaled by the sum of pretax income (net of special items) over one year. We focus on the *Cash ETR* because this measure reflects permanent and temporary tax deferral strategies, both of which retain cash resources within the firm (Koester et al. 2017). In addition to the one-year *Cash ETR*, we also use the *Long-run Cash ETR1*, estimated as the five-year-centered moving sum of cash paid for income taxes over five years scaled by the sum of pretax income (net of special items) over the same period (see Dyreng et al. 2008). The *Long-run Cash ETR2* is an extended measure estimated as the five-year-centered moving sum of cash paid for income taxes plus the excess tax benefit of stock options (Compustat variable TXBCO and TXBCOF) scaled by the sum of pretax income (net of special items) over the same period. This generates an effective cash tax rate that more closely tracks the firm's tax costs over the long run, and it avoids year-to-year volatility in annual ETRs. Firms that conduct more tax avoidance activities should have lower ETRs.

Our measure of tax sheltering was constructed by Wilson (2009) to estimate the propensity of firms to engage in tax sheltering based on the shelter probability computed by using the estimates from the following logit regression model:

$$Shelter\ Prob. = -4.30 + 6.63 \times BTD - 1.72 \times Lev + 0.66 \times Size + 2.26 \times ROA + 1.62 \times FI + 1.56 \times RD \quad (1)$$

where *BTD* is the book tax difference, *Lev* is the long-term debt scaled by total assets; *Size* is the log of total assets; *ROA* is the net-income scaled by total assets; *FI* is a dummy variable, coded one for firms with foreign income and zero otherwise; and *RD* is the research and development expenses scaled by total assets. We follow Rego and Wilson (2012), Hoi, Wu, and Zhang (2013),

and Khurana and Moser (2013) and construct a dummy variable, *Shelter Dummy*, that equals one if a firm's estimated shelter probability belongs to the top quartile and zero otherwise.

2.2 Price Informativeness Measures

Our empirical analysis is focused on managers learning from private information in prices in tax management. We use price nonsynchronicity to determine the extent of private information contained in stock prices. Roll (1988) introduced this measure as an indication of private information and empirically demonstrated that price nonsynchronicity has only a very small correlation with public news. Subsequent studies find additional evidence that price nonsynchronicity measures more private information than just noises (Durnev et al. 2003; Durnev et al. 2004). Therefore, many empirical studies use price nonsynchronicity to measure private information in stock prices (Chen, et al. 2007; Ferreira and Laux 2007; Ferreira et al. 2011; Fresard 2012; Mathers et al. 2017). We compute this measure by estimating 1-R^2, where R^2 is the R-square from the following regression:

$$r_{i,j,t} = \beta_{i,0} + \beta_{i,m} \times r_{m,t} + \beta_{i,j} \times r_{j,t} + \varepsilon_{i,t}, \quad (2)$$

where $r_{i,j,t}$ is the return of firm *i* in industry *j* at time *t*, $r_{m,t}$ is the market return at time *t*, and $r_{j,t}$ is the return of industry *j* at time *t*. The idea is that if a firm's stock return is less correlated with the market and industry returns, then the firm's stock price is more likely to convey firm-specific information, which is useful for managerial tax planning decisions. Thus, a higher value in 1-R^2 should indicate more private information impounded in stock prices (Roll 1988; Chen et al. 2007).

2.3 Managerial Ability Measures

We measure *Managerial Ability* by the MA-Score developed in Demerjian et al. (2012). The measure is constructed using a two-stage approach as the first stage uses data development analysis (DEA) to capture how efficiently firm resources are managed to generate revenues relative to a firm's industry competitors. This is achieved by optimizing total sales using the vector of inputs including cost of goods sold, SG&A, net PP&E, operating leases, R&D, purchased goodwill and intangibles.

$$max\ \theta_t = (Sales_t) \cdot (v_1 COGS_t + v_2 SG\&A_t + v_3 PPE_t + v_4 OpsLease_t + v_5 R\&D_t + v_6 Goodwill_t + v_7 OtherIntan_t)^{-1} \quad (3)$$

The DEA optimization determines a firm-specific vector of optimal weights on the seven input variables by comparing the inputs of firm *i* to the inputs of all other firms within the same industry-year and computes a firm efficiency score θ that takes a value between 0 (least efficient firms) and 1 (most efficient firms). The second stage isolates the portion of the efficiency score attributable to managerial ability by estimating the following cross-sectional regression on firm-year level:

$$\theta_{i,t} = \alpha_0 + \beta_1 \cdot \ln(Total\ Assets_{i,t}) + \beta_2 \cdot Market\ Share_{i,t} + \beta_3 \cdot Positive\ Free\ CF_{i,t} + \beta_4 \cdot \ln(Age_{i,t}) + \beta_5 \cdot Business\ Segment\ Concentration_{i,t} + \beta_6 \cdot Foreign\ Currency\ Indicator_{i,t} + Year\ FEs + \varepsilon_{i,t} \quad (4)$$

Managerial Ability is constructed using the unexplained portion of θ, e.g., the residual of this regression, ranked with its industry peers. Unlike other measures of managerial ability used in prior literature (e.g., longer CEO tenure, higher CEO pay, higher historical stock and accounting performance, more CEO media mentions, etc.), this measure directly captures executives' capability to manage resources efficiently.

2.4 Other Variables

We control for several firm level characteristics. *Firm Size* is the natural logarithm of total book assets. *ROA* is net income divided by firm's book assets. *EBIT/Sale* is the firms' EBIT scaled by total sales revenue. *Leverage* is the sum of long-term and short-term debt scaled by firm's book assets. We measure the firm's earnings quality by *Discretionary Accruals*. Following Hong et al. (2014), we estimate the absolute value of discretionary accruals using the performance-controlled cross sectional modified Jones (1991) model to control for aggressive financial reporting practices (Kothari et al. 2005). Larger values in *Discretionary Accruals* indicate higher earnings management and lower earnings quality.

In our extended tests, we control for public information using *Analyst Coverage*, which is the number of analysts covering the firm *i* in year *t*. We measure market liquidity using the bid-ask spread.[5] We use two measures of financial constraints suggested by the prior literature. The first is Altman Z score based on Altman (1968).[6] The second measure is WW score based on White and Wu (2006).[7] We consider the effect of corporate governance by calculating *Institutional Ownership*, which is the fraction of a firm's common equity owned by institutional shareholders and a widely used measure for external monitoring from institutional investors. Lastly, firms with tax avoidance incentives may intentionally allocate portions of assets overseas to exploit

[5] Bid-ask spread is calculated as (Ask-Bid)/(midpoint of ask and bid price) from CRSP.

[6] Altman Z-Score is modeled as 1.2*(working capital / total assets) + 1.4*(retained earnings / total assets) + 3.3*(earnings before interest and tax / total assets) + 0.6*(market value of equity / total liabilities) + 1.0*(sales / total assets).

[7] WW score is modeled as -0.091*(cash flow/total assets) - 0.062*positive dividend + 0.021*(long-term debt/total assets) - 0.044 * (log of total assets) + 0.102*industry sales growth-0.035 * firm sales growth. Positive dividend is an indicator that equals 1 if the firm pays cash dividends.

jurisdictional variance in tax rates. We create a dummy variable, *Foreign Income* indicating if the firm has foreign earnings in year t.

2.5 Summary Statistics

We report the summary statistics of all variables in Table 1. The mean *Cash ETR* in our sample is 25.9 percent (median is 25.6 percent), comparable with descriptive statistics reported in prior studies (Dyreng et al. 2010; Edwards et al. 2016; Koester et al. 2017; Bayar et al. 2018).[8] Consistent with Dyreng et al. (2010) and Koester et al. (2017), values for the *Long-run Cash ETR* measures are higher than our one-year measure. The mean value in $1\text{-}R^2$ is 0.791, indicating that on average, the market and industry returns can explain only about 20 percent of firms' return variations, consistent with Chen et al. (2007). The average Q in our sample is 1.96. The mean value in *Managerial Ability* is about 0.02, which is comparable with the MASCORE in Koester et al. (2017).

[Insert Table 1 about here]

Table 2 presents the Pearson correlations between variables. We find a significant negative relation between ETR measures and *Q*, indicating that corporate tax avoidance is positively related to stock prices. On the other hand, ETR measures are positively correlated with $1\text{-}R^2$, implying that greater price informativeness is associated with lower corporate tax avoidance. Most of the firm characteristics exhibit significant correlations with our tax avoidance measures, highlighting the importance of controlling for these variables in our multivariate analysis.

[8] This rate is much lower that the statutory federal tax rate of 35 percent. In dollar terms, reducing tax liability by 1% of pretax income of an average firm can result in savings of about $3.2 million per year (mean pretax income in our sample is about $320 million). For most profitable firms, tax savings from a similar reduction in the tax rate may amount as high as $280 million during a year. Thus, saving cash taxes by a few percentage points can have a significant positive impact on a firm's financial flexibility.

[Insert Table 2 about here]

3. Empirical Design and Results

3.1 Baseline Results

In this section, we empirically assess the hypothesis that managers learn from the private information in stock price when they make tax planning decisions. We perform panel regressions at the firm-year level to examine the effect of private information on the sensitivity of corporate tax avoidance to price. Our baseline regression is as follows:

$$Tax\ Avoidance_{i,t} = \alpha_0 + \beta_1 \cdot Q_{i,t} + \beta_2 \cdot (1 - R^2)_{i,t} + \beta_3 \cdot (1 - R^2) \cdot Q_{i,t} + \gamma \cdot X'_{i,t} + Year\ FEs + Firm\ FEs + \varepsilon_{i,t} \quad (5)$$

The dependent variable is a set of corporate tax avoidance measures including *Cash ETR*, *Long-run Cash ETR1*, *Long-run Cash ETR2*, and *Shelter Dummy*. *Q* represents the firm's stock price. *1-R^2* is our measure for price informativeness and captures private information contained in prices. (*1-R^2)*Q* is their interaction and our independent variable of interest. $X'_{i,t}$ stands for the set of firm characteristics presented in Table 2. We also control for year and firm fixed effects. All continuous variables are winsorized at the 1% and 99% levels and standard errors are clustered at the firm level to reflect the dependencies of observations that belong to same firms.

Table 3 reports our baseline regression estimates. We first investigate whether managers learn from stock prices to conduct tax avoidance activities by estimating the Eq.5 without interactions. In columns (1) - (4), we find that tax avoidance is positively associated with stock price, as the coefficients for *Q* in the models estimating ETR measures are significantly negative and the coefficient for *Q* in the model estimating *Shelter Dummy* is significantly positive. The

coefficients are statistically significant at 1%. This finding confirms our hypothesis that managers learn from stock prices to invest more in tax efficient assets. Our variable of interest is $(1\text{-}R^2)*Q$, which measures how private information in stock price that is new to managers affects the sensitivity of tax avoidance to stock price. In columns (5)-(7), the coefficients for $(1\text{-}R^2)*Q$ are significantly negative at the 1% level, and in column (8), the coefficient for $(1\text{-}R^2)*Q$ is significantly positive at the 1% level. The findings suggest that tax avoidance is more sensitive to stock price when the stock price contains a larger amount of private information that is new to managers. For instance, the tax avoidance-to-price sensitivity will increase by 57.14 percent if a firm's $1\text{-}R^2$ increases from a 25th percentile value (0.672) to a 75th percentile value (0.954). In other words, managers obtain larger corporate tax savings following a positive shock to Tobin's Q (stock price) when this signal contains a larger amount of investors' private information.[9]

[Insert Table 3 about here]

3.2 Instrumental Variable Analysis

Endogeneity concerns may arise in multiple ways in the relation between price informativeness and the tax avoidance-to-price sensitivity. We note that the potential endogeneity problem where price informativeness and tax avoidance-to-price sensitivity are jointly determined could be mitigated by using the fixed effects regression method. Firm fixed effects address endogeneity concerns in which unobserved time-invariant firm-specific variables simultaneously

[9] Our findings are qualitatively similar when we use the probability of informed trading (PIN) measure developed in by Easley, Hvidkjaer, O'Hara (2002) and estimated by Brown and Hillegeist (2007). Their updated PIN estimate covers our sample period from 1993 to 2010. The results are available upon request.

determine both price informativeness and tax avoidance-to-price sensitivity. This is also equivalent to looking only at within-firm changes in price informativeness $1\text{-}R^2$.[10]

To further mitigate endogeneity concerns, we conduct an instrumental variable (IV) analysis using the two-stage least squares (2SLS) regression method to directly address the potential endogeneity of price informativeness. The instrumental variable analysis allows us to mitigate omitted variable biases that vary with time and potential reverse causality from tax avoidance to stock price informativeness. The key to this method is that we require the use of instruments that are correlated with price informativeness but uncorrelated with tax avoidance. We use two instruments for price informativeness. First, we acquire the list of Autoquote introduction to every NYSE listed firm.[11] Autoquote is a structural change in NYSE market, and according to Hendershott et al. (2011), it exogenously causes increase in algorithm trading and as a result improves market liquidity and affects informativeness in stock quotes. We create an indicator variable *Event* that equals zero for the years before the Autoquote introduction and one afterwards, and another indicator variable *Treatment* that equals one for NYSE-listed firms and zero for Nasdaq listed firms. The instrument is *Event***Treatment*. Our second instrument is *S&P 500 Inclusion*, which equals zero for the years before adding to the S&P 500 index and one afterwards. Wurgler (2010) finds that stock returns of newly added S&P 500 firms become more correlated with other firms in the index and less correlated with the rest of the market causing their prices to

[10] Another approach to alleviate endogeneity concern is to use lagged price informativeness and explanatory variables. In unreported tests, our findings confirm a positive enhanced relation between price informativeness and tax avoidance-to-price sensitivity.

[11] The NYSE began to phase in the Autoquote software on January 29, 2003, starting with six active, large-cap stocks. During the next 2 months, over 200 additional stocks were phased in at various dates, and all remaining NYSE stocks were phased in on May 27, 2003.

become less reflective of firm-specific information.[12] However, neither of the measures are documented to directly affect firms' tax avoidance level. Hence, we believe these two instruments meet both the relevance and exclusion restrictions.

Our 2SLS regression results are presented in Table 4. In each model, we first regress the endogenous variable ($1\text{-}R^2$) and its interaction $(1\text{-}R^2)*Q$ on the instrument variables *Event*Treatment*, *Event*Treatment*Q*, *S&P 500 Inclusion*, and *S&P 500 Inclusion*Q*, together with other control variables. In the first stage regressions, consistent with our expectation, we document a significant relation between our instruments and the endogenous variables. The first-stage F-statistics are significantly large rejecting the hypothesis that the instruments are weak. In the second stage regressions, there is still evidence of a positive relation between private information in prices and tax avoidance-to-price sensitivity. As shown in Model IV, the coefficient for the instrumented $(1\text{-}R^2)*Q$ is 0.148 with a t-statistic of 2.26, suggesting that managers learn from stock prices to conduct tax sheltering when there is more private information contained in prices. Moreover, we note that Sargan-Hansen statistic for overidentifying test is 3.62, which indicates we cannot reject the joint null hypothesis that the instruments are valid instruments (uncorrelated with the error term). The results are also robust when we include additional firm characteristics and year and firm fixed effects. Taken together, the baseline and IV results support the hypothesis that managers use part of the private information embedded in stock price when they make tax avoidance decisions.

[Insert Table 4 about here]

[12] Morck and Yang (2001) note a significant price premium for those stocks in the S&P 500 index indicating that their prices are detached from fundamentals. Mathers et al. (2017) document that the S&P 500 inclusion indicator is significantly negatively related to stock price informativeness.

3.3 Robustness Tests Controlling for Alternative Factors

To lend additional support for the findings in our baseline tests above, in this section, we extend the empirical analysis by also controlling for managerial ability, public information, financial constraints, and corporate governance.

3.3.1 Controlling for Managerial Ability

Koester et al. (2017) argue that executives with greater ability to manage resources efficiently engage in greater corporate tax avoidance. High-ability managers have a superior understanding of their firms' operating environment, enabling them to better align business decisions with tax strategies and identify tax saving opportunities. Therefore, we test whether the previous results are robust to the insertion of the managerial ability proxy in the baseline specification (Eq. 5) and estimate its effect on the estimated tax avoidance-to-price sensitivity.

The results are reported in Table 5. We use the *Managerial Ability* variable following the methodology of Demerjian et al. (2012) as described in Section 3.3. We find that *Managerial Ability* is significantly negatively associated with long-term cash ETR measures and significantly positively related to tax sheltering. This is consistent with the finding of Koester et al. (2017) that managers with superior ability engage in more tax planning activities. Notably, the coefficients of *Managerial Ability*Q* are significantly positive in the models featuring cash ETR measures and significantly negative in the model featuring *Shelter Dummy*. This negative effect of *Managerial Ability* on tax avoidance-to-price sensitivity is consistent with the notion that when managers possess superior ability, they rely less on the information in stock price in their tax planning decisions and the marginal learning effect is smaller. We conclude that our main results are robust to the inclusion of managerial ability.

[Insert Table 5 about here]

3.3.2 Controlling for Public Information

So far, our results are consistent with the prediction that managers learn some private information from prices and use this information in their tax planning activities. However, the significant association we document would only be reflective of managerial learning to the extent that the private information in price is *new* to managers (they have not learned it elsewhere). Testing this hypothesis is challenging because we do not directly observe the information set used by managers for their tax management decisions. However, to overcome this potential problem of identification, we gauge whether other competing sources of information affect the tax avoidance-to-price sensitivity. We expect that the extent of available public information attenuates the sensitivity of tax avoidance to stock price because managers already know this information through other channels. To test this conjecture, we first measure the public information contained in market liquidity captured by bid-ask spread. *BA Spread* is calculated by the spread between the bid and ask price scaled by the midpoint and reflects the market liquidity of the stock.

We report this result in Panel A of Table 6. As shown in columns (1) and (4), the *BA Spread* is significantly negatively associated with *Cash ETR* and significantly positively associated with tax sheltering. This indicates lower market liquidity is associated with greater corporate tax avoidance (higher values in *BA Spread* indicates lower market liquidity). Furthermore, the coefficients for *BA Spread*Q* are significantly negative in the models characterizing *Cash ETR* and *Long-run Cash ETRs* and significantly positive in the model characterizing tax sheltering. This finding implies that the price sensitivity of tax avoidance is attenuated when managers learn from other (public) information channels, specifically the observed liquidity reflected by order flows (when investors have more information, the order flows tend to increase, and this consequently increases the stock's market liquidity and lowers the bid-ask spread).

Our second measure to quantify public information is the number of analysts covering a firm, which constitutes an important source of information in financial markets. The effects of analyst coverage may arise in two opposite ways. If the information produced by analysts and impounded in the stock price is new to managers, we should expect a positive relation between analyst coverage and tax avoidance-to-price sensitivity. A more commonly held view is that if analysts mainly transfer information from managers to investors, the content of information they release is unlikely to be new to managers (Chen et al. 2007; Fresard 2012) and thus suggesting a negative relation between analyst coverage and tax avoidance-to-price sensitivity.

We report this result in Table 6, Panel B. Although we find a significant positive association between analyst coverage and tax avoidance as shown in columns (2) and (4), we do not observe any significant coefficient for *Analyst Coverage*Q*. Therefore, we cannot draw conclusions on whether the information released by analysts is new to managers or not and whether it affects the managerial learning from private information in stock prices. However, we can confirm that the main results are not affected by the inclusion of measures of alternative sources of information.

[Insert Table 6 about here]

3.3.3 Controlling for Financial Constraints

Several empirical studies documented that financial constraints are associated with more aggressive tax planning strategies (Law and Mills 2015; Edwards et al. 2016; Bayar et al. 2018). Financially constrained firms may employ tax planning as a source of funds and in our setting, the tax avoidance-to-price sensitivity may depend on the extent of financial constraints they face. Therefore, we test how financial constraints affect the tax avoidance-to-price sensitivity using two commonly used constraint measures, Altman Z score and WW score, as described in Section 3.4

Panel A of Table 7 reports the results using Altman Z score. We find a significant positive association between Altman Z score and Long-run Cash ETR measures and a significant negative relation between Altman Z score and tax sheltering. Since higher values in Altman Z score indicate lower financial constraints, this result is consistent with prior literature on the view that more financially constrained firms intend to accrue more cash tax savings. On the other hand, we observe that higher financial constraints reduce the tax avoidance-to-price sensitivity, as the coefficients of *Altman Z*Q* are significantly negative for long-term cash ETRs and significantly positive for the *Shelter Dummy*.

When we use an alternative proxy for financial constraints, *WW score*, the results are consistent with those reported above. In Panel B of Table 7, we report a significant negative association between *WW score* and *Long-run Cash ETR2*, and a significant positive relation between *WW score* and tax sheltering. The *WW score*Q* is significantly positively related to *Long-run Cash ETR* measures and significantly negatively related to tax sheltering. Hence, we confirm that financial constraints decrease the tax avoidance-to-price sensitivity. A plausible explanation is that when managers face strong financial constraints, the pressure to conduct tax avoidance activities and save for internal funds dominates the marginal learning effect from private information obtained in the stock market.

[Insert Table 7 about here]

3.3.4 Controlling for External Governance

Extant literature has noted a significant effect of managerial incentives on corporate tax avoidance behavior. Armstrong et al. (2015) argue that better governance structure and financial sophistication mitigate agency problems related to the level of tax aggressiveness. Khan et al. (2017) find that positive shocks to institutional ownership lead to significant increases in tax

avoidance activities. They conclude that improved monitoring by institutional ownership increases the value efficiency of avoiding taxes. In this section, we test whether our main results are robust to the addition of external governance measure.

We use *Institutional Ownership,* defined as the fraction of a firm's common equity owned by institutional investors, as the measure of external monitoring by institutional investors. The results are reported in Table 8. Consistent with Khan et al. (2017), we find some evidence that tax sheltering is increased with higher institutional ownership, as shown in the column (4) of Table 8. Furthermore, the coefficients of *Institutional Ownership*Q* are significantly negative in columns (1) and (3), suggesting that external monitoring has a significant positive impact on tax avoidance-to-price sensitivity. Since shareholders weigh the benefits of tax avoidance against the costs of potential enforcement, penalties, and reputation loss to the firm if the strategy is flagged by tax authorities (Hanlon and Heitzman 2010; Khan et al. 2017), institutional ownership is likely to enhance the managerial learning from stock prices in tax planning decisions when shareholders' assessment of the cost-benefit tradeoff of tax avoidance is aligned with managers' private assessment of it. Although this result is not particularly strong, we confirm that our main results are not affected by the inclusion of the external governance measure.

[Insert Table 8 about here]

3.4 Do Managers Learn More When There is More to Learn?

If private information contained in stock price can affect the tax avoidance-to-price sensitivity, it is likely that managers learn more from stock price when there is more to learn. To test this conjecture, we sort the full sample into quintiles based on (1-R^2). We repeat the regressions in the specification of Eq.5 for each quintile-based subsample. The dependent variable is *Shelter*

Dummy. As shown in Table 9, we find that the coefficients of $(1-R^2)*Q$ are more statistically significant in subsamples with higher quintiles of private information.[13] This finding confirms the managerial learning effect and indicates that managers learn more about their tax avoidance decisions when there is more private information embedded in stock price.

[Insert Table 9 about here]

4. Heterogeneity Tests

In this section, we perform two heterogeneity tests to see if our main results vary in firms with high capital intensity versus low capital intensity, and firms with foreign operations and entirely domestic operations.

4.1 Capital Intensity

It is well documented that managers learn from stock prices in their capital investment decisions. Chen et al. (2007) argue that private information in stock prices enhances the investment-to-price sensitivity. We test the heterogeneity of capital intensity in our results. We split the sample into high capital intensity firms and low capital intensity firms based on median value in capital expenditure scaled by total book assets. Then we perform our baseline regression in each sample. The results are presented in Table 10.

As shown in Table 10, we find that the positive effect of price informativeness on the tax avoidance-to-price sensitivity is more pronounced in the subsample of firms with high capital intensity. The coefficients for $(1-R^2)*Q$ are larger in both statistical significance and economic magnitude in high capital intensity firms in each model characterizing our four tax avoidance

[13] Our results remain qualitatively unchanged when we use quartile regressions based on *(1-R2)*.

measures. Furthermore, the Chow-test statistics also show we reject the null hypothesis that the coefficients are jointly equal comparing the models in the two subsamples.

[Insert Table 10 about here]

4.2 Foreign Operations

Lastly, we test if the effects we documented are stronger in firms with multinational operations. Firms accused of using more tax shelters are documented to have larger book-tax differences, more foreign operations, subsidiaries in tax havens, and higher pre-tax income (Rego 2003; Wilson 2009; Lisowsky 2010). Firms can delay financial statement recognition of U.S. taxes on repatriations by designating foreign earnings as "permanently reinvested" (Krull 2004). Furthermore, some estimates suggest that little U.S. tax is collected on foreign earnings (Hines and Rice 1994; Dyreng and Lindsey 2009). Therefore, it is possible that managerial learning from private information in prices when making tax strategies may be reinforced if the firm has foreign operations.

To test this conjecture, we perform our baseline regressions in the subsamples split by *Foreign Income*, which indicates if a firm has foreign earnings in a given year t. We report this result in Table 11. We find that the coefficients for $(1-R^2)$ are larger in statistical significance and economic magnitude in the firms with foreign income, as well as the coefficient for $(1-R^2)*Q$ in the model characterizing tax sheltering. Model explanatory power is also greater in the subsample with foreign income. The Chow-test statistics are at least above 6.0 indicating we reject the null hypothesis that the estimates across the two subsamples are equal. This finding provides some support for the conjecture that for the firms with foreign earnings, tax avoidance-to-price sensitivity is stronger when stock prices contain more private information.

[Insert Table 11 about here]

5. Conclusion

In this paper, we investigate whether managers learn information from the stock market and use this information when forming corporate tax avoidance strategies. Our first important finding is that tax avoidance is positively associated with stock price information, confirming managerial learning from stock prices in tax planning activities. Using price nonsynchronicity as the measure for price informativeness, we document that corporate tax avoidance is more sensitive to stock price when the price contains a larger amount of private information.

To address the potential endogeneity issue in the relation between a firm's stock price informativeness and tax avoidance, we use two exogenous factors and confirm the effect in an instrumental two-stage least squares analysis. We further validate that the relation is robust to the inclusion of controls for managerial ability, public information, financial constraints, and external governance. The effect we document is stronger in the firms with high capital intensity and foreign income. Overall, our results are consistent with the hypothesis that managers extract valuable private information from stock prices to use in their tax-related decisions. This outcome supports the prior literature indicating that financial markets affect the real economy. Our findings also imply that the private information contained in the stock price may reflect shareholders' assessment of the cost-benefit tradeoff of corporate tax avoidance.

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Table 1: Summary Statistics

This table presents the summary statistics for tax avoidance, managerial ability measure, financial constraint measures, information asymmetry measures, corporate governance measures, as well as the control variables in the firm-year data that covers the period of 1970-2018. All continuous variables are winsorized at the 1% and 99% levels. Descriptions of each variable are provided in Appendix I.

	N	Mean	SD	p25	Median	p75
Cash ETR	43,501	0.259	0.172	0.128	0.256	0.359
Long-run Cash ETR1	32,431	0.262	0.143	0.165	0.268	0.350
Long-run Cash ETR2	34,060	0.285	0.153	0.187	0.292	0.371
Shelter Dummy	25,495	0.440	0.496	0.000	0.000	1.000
(1-R2)	43,495	0.791	0.202	0.672	0.865	0.954
Q	43,452	1.955	1.334	1.171	1.539	2.226
Firm size	43,500	6.289	2.158	4.721	6.227	7.765
ROA	43,500	0.071	0.057	0.035	0.062	0.098
EBIT/Sale	43,483	0.119	0.163	0.059	0.100	0.160
Discretionary Accruals	43,042	0.048	0.306	-0.042	0.012	0.088
Leverage	43,362	0.214	0.181	0.052	0.195	0.326
Capex/Assets	43,105	0.064	0.062	0.024	0.046	0.082
Managerial Ability	43,092	0.018	0.131	-0.061	-0.006	0.059
BA Spread	35,866	0.020	0.031	0.001	0.009	0.026
Analyst Coverage	43,501	2.696	4.382	0.000	0.000	4.000
Altman Z	42,088	5.392	5.494	2.606	3.888	5.993
WW score	43,295	-0.310	0.111	-0.390	-0.308	-0.229
Institutional Ownership	30,143	0.512	0.318	0.231	0.534	0.776
Foreign Income	43,501	0.493	0.500	0.000	0.000	1.000

Table 2: Pairwise Correlations

This table reports Pearson pairwise correlations. Two-tailed p-values are reported under the coefficients. All continuous variables are winsorized at the 1% and 99% levels. Descriptions of each variable are provided in Appendix I.

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]
[1] Cash ETR	1.000										
[2] Long-run Cash ETR1	0.688	1.000									
	0.000										
[3] Long-run Cash ETR2	0.616	0.848	1.000								
	0.000	0.000									
[4] Shelter Dummy	-0.040	-0.033	0.011	1.000							
	0.000	0.000	0.104								
[5] 1-R^2	0.061	0.069	0.035	-0.478	1.000						
	0.000	0.000	0.000	0.000							
[6] Q	-0.074	-0.118	-0.105	-0.014	-0.010	1.000					
	0.000	0.000	0.000	0.000	0.000						
[7] Firm Size	0.022	0.027	0.070	0.686	-0.561	-0.105	1.000				
	0.000	0.000	0.000	0.000	0.000	0.000					
[8] ROA	-0.024	0.130	0.149	0.265	-0.148	-0.239	0.305	1.000			
	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
[9] EBIT/Sale	-0.053	0.120	0.128	0.147	-0.087	-0.260	0.200	0.559	1.000		
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			
[10] Discretionary Accruals	-0.029	-0.017	-0.017	0.048	0.002	0.004	0.002	0.200	0.086	1.000	
	0.000	0.001	0.001	0.000	0.658	0.271	0.534	0.000	0.000		
[11] Leverage	-0.054	-0.052	-0.056	-0.022	0.007	-0.086	0.144	-0.084	0.069	-0.058	1.000
	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.000	

Table 3: The Impact of Price Informativeness on Tax Avoidance-to-Price Sensitivity

This table presents estimates of panel regressions to examine the impact of price informativeness on tax avoidance-to-price sensitivity. The dependent variables are tax avoidance measures including *Cash ETR, Long-run Cash ETR1, Long-run Cash ETR2,* and *Shelter Dummy*. The effect of price informativeness on the tax avoidance-to-price sensitivity is measured by *(1-R2)*Q*. The t-statistics are reported in parentheses. All specifications include year and firm fixed effects. Standard errors are clustered at the firm level. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. Descriptions of all the variables are provided in Appendix I.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Cash ETR	Long-run Cash ETR1	Long-run Cash ETR2	Shelter Dummy	Cash ETR	Long-run Cash ETR1	Long-run Cash ETR2	Shelter Dummy
Q	-0.007***	-0.010***	-0.010***	0.014***	-0.001	-0.001	-0.001	0.001
	(-8.207)	(-12.825)	(-12.409)	(12.982)	(-1.160)	(-0.914)	(-0.858)	(1.449)
(1-R2)*Q					-0.006***	-0.010***	-0.010***	0.012***
					(-3.157)	(-5.457)	(-5.008)	(6.754)
(1-R2)					0.026***	0.036***	0.039***	-0.164***
					(3.662)	(5.629)	(5.631)	(-14.666)
Firm size	0.019***	0.016***	0.021***	0.115***	0.019***	0.017***	0.022***	0.109***
	(12.068)	(11.027)	(13.482)	(47.313)	(12.334)	(11.518)	(14.042)	(43.729)
ROA	-0.179***	-0.102***	-0.114***	0.082***	-0.183***	-0.103***	-0.116***	0.085***
	(-9.323)	(-13.066)	(-12.280)	(10.516)	(-9.602)	(-13.265)	(-12.546)	(10.891)
EBIT/Sale	-0.005	0.005***	0.007***	-0.002*	-0.005	0.005***	0.007***	-0.002
	(-0.738)	(2.624)	(3.275)	(-1.710)	(-0.788)	(2.636)	(3.282)	(-1.485)
Discretionary Accruals	0.005**	0.000	-0.002	0.028***	0.005**	0.000	-0.002	0.028***
	(2.083)	(0.046)	(-0.972)	(7.285)	(2.099)	(0.045)	(-0.976)	(7.267)
Leverage	-0.056***	-0.025***	-0.019***	-0.223***	-0.057***	-0.025***	-0.020***	-0.217***
	(-7.331)	(-3.655)	(-2.604)	(-20.590)	(-7.414)	(-3.756)	(-2.663)	(-20.125)
Constant	0.210***	0.226***	0.225***	-0.351***	0.185***	0.188***	0.183***	-0.193***
	(15.928)	(18.472)	(18.172)	(-16.217)	(12.726)	(13.632)	(12.868)	(-8.142)
Observations	42860	39257	39967	42936	42854	39255	39965	42926
R-square	0.032	0.040	0.033	0.163	0.032	0.040	0.033	0.167
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 4: Instrumental Variable Analysis

This table presents estimates of 2SLS instrumental variable regressions to examine the impact of price informativeness on tax avoidance-to-price sensitivity. *Event* is an indicator equal 1 for years after the Autoquote introduction and *Treatment* is an indicator equal 1 for firms listed on NYSE and zero for Nasdaq firms. *S&P 500 Inclusion* is a dummy variable equal 1 if a firm is included in the S&P 500 index for a given year t and zero otherwise. *Event*Treatment* and *S&P 500 Inclusion* are the instruments for *(1-R2)*. Panel A presents the first stage estimations where the dependent variables are *(1-R2)* and *(1-R2)*Q* (endogenous variables). Panel B presents the second stage estimations where the dependent variables are tax avoidance measures including *Cash ETR*, *Long-run Cash ETR1*, *Long-run Cash ETR2*, and *Shelter Dummy*. The t-stats are reported in parentheses. All specifications include year and firm fixed effects. Standard errors are clustered at the firm level. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. Descriptions of all the variables are provided in Appendix I.

Panel A	*First Stage Estimations*							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	1-R2	(1-R2)*Q	1-R2	(1-R2)*Q	1-R2	(1-R2)*Q	1-R2	(1-R2)*Q
Event*Treatment	-0.186***	-0.201***	-0.172***	-0.188***	-0.179***	-0.205***	-0.190***	-0.430***
	(-21.65)	(-3.86)	(-19.03)	(-3.70)	(-20.12)	(-4.03)	(-20.06)	(-7.52))
Event*Treatment*Q	0.022***	-0.014	0.018***	-0.005	0.019***	-0.001	0.022***	0.144***
	(5.45)	(-0.46)	(4.28)	(-0.15)	(4.68)	(-0.01)	(5.18)	(3.94)
Q	-0.001	0.530***	-0.003***	0.544***	-0.004***	0.543***	-0.002***	0.399***
	(-1.37)	(11.61)	(-3.67)	(13.98)	(-4.35)	(15.30)	(-4.71)	(7.98)
S&P 500 Inclusion	-0.048***	-0.266**	-0.039**	-0.199*	-0.043***	-0.185*	-0.028	-0.385**
	(-3.08)	(-2.23)	(-2.43)	(-1.66)	(-2.64)	(-1.65)	(-1.58)	(-2.50)
S&P 500 Inclusion*Q	0.001	0.028	-0.003	0.001	-0.003	-0.002	-0.003	0.126**
	(0.37)	(0.69)	(-0.92)	(0.03)	(-0.78)	(-0.06)	(-0.90)	(2.34)
Constant	1.290***	1.587***	1.330***	1.882***	1.327***	1.846***	1.214***	2.414***
	(92.01)	(12.96)	(88.46)	(13.30)	(85.98)	(14.67)	(106.71)	(10.42)
F-statistics	332.61	722.24	305.67	599.66	319.16	546.25	246.32	385.80

Panel B	*Second Stage Estimations*			
	Model I	Model II	Model III	Model IV
	Cash ETR	Long-run Cash ETR1	Long-run Cash ETR2	Shelter Dummy
Instrumented (1-R2)	0.159**	0.073	0.001	-0.551***
	(2.004)	(0.612)	(0.006)	(-4.658)
Instrumented (1-R2)*Q	0.038	0.097	0.138	0.148**
	(0.839)	(1.252)	(1.420)	(2.357)
Q	-0.026	-0.059	-0.081	-0.054*
	(-1.060)	(-1.429)	(-1.582)	(-1.785)
Constant	0.038	0.034	0.043	-0.113
	(0.821)	(0.656)	(0.807)	(-1.049)
Observations	35,654	32,513	33,067	35,336
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes

Table 5: Managerial Ability, Price Informativeness, and Tax Avoidance-to-Price Sensitivity

This table presents estimates of panel regressions to examine the impact of price informativeness on tax avoidance-to-price sensitivity after controlling for managerial ability. The dependent variables are tax avoidance measures including *Cash ETR*, *Long-run Cash ETR1*, *Long-run Cash ETR2*, and *Shelter Dummy*. Managerial Ability is the MA score from Demerjian et al. (2012), computed using data envelopment analysis (DEA) where total sales is optimized using the vector of inputs including net PP&E, operating leases, R&D, purchased goodwill and intangibles, cost of goods sold, and SG&A. The DEA is optimized at the industry and year levels, and a firm efficiency score is computed. The firm efficiency score is then regressed on firm characteristics (size, market share, positive free cash flow, age, business segment concentration, a foreign currency indicator, and year indicators), and the residual from this regression is the managerial ability score. See Demerjian et al. (2012) for additional details. The t-statistics are reported in parentheses. All specifications include year and firm fixed effects. Standard errors are clustered at the firm level. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. Descriptions of all the variables are provided in Appendix I.

	(1) Cash ETR	(2) Long-run Cash ETR1	(3) Long-run Cash ETR2	(4) Shelter Dummy
(1-R2)*Q	-0.007***	-0.011***	-0.010***	0.012***
	(-3.388)	(-6.053)	(-5.248)	(6.060)
(1-R2)	0.028***	0.038***	0.040***	-0.161***
	(3.883)	(5.804)	(5.733)	(-14.007)
Q	-0.002	-0.002	-0.002	0.001
	(-1.227)	(-1.243)	(-1.263)	(0.848)
Managerial Ability	0.023	-0.064***	-0.034**	0.145***
	(1.404)	(-4.451)	(-2.199)	(5.696)
Managerial Ability*Q	0.006	0.031***	0.021***	-0.023**
	(0.863)	(5.243)	(3.291)	(-2.527)
Constant	0.185***	0.191***	0.185***	-0.212***
	(12.695)	(13.793)	(12.893)	(-8.766)
Observations	42,553	38,835	39,553	41,922
R-square	0.033	0.041	0.034	0.171
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes

Table 6: Public Information, Price Informativeness, and Tax Avoidance-to-Price Sensitivity

This table presents estimates of panel regressions to examine the impact of price informativeness on tax avoidance-to-price sensitivity after controlling for market information. Panel A presents the regression results after controlling for *Bid-Ask spread*, which is calculated as (Ask-Bid)/(midpoint of ask and bid price). Panel B presents the regression results after controlling for *Analyst Coverage*, which is the natural logarithm of the number of analysts covering the firm in a given year t. The dependent variables are tax avoidance measures including *Cash ETR*, *Long-run Cash ETR1*, *Long-run Cash ETR2*, and *Shelter Dummy*. The t-statistics are reported in parentheses. All specifications include year and firm fixed effects. Standard errors are clustered at the firm level. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. Descriptions of all the variables are provided in Appendix I.

Panel A	(1) Cash ETR	(2) Long-run Cash ETR1	(3) Long-run Cash ETR2	(4) Shelter Dummy
(1-R2)*Q	-0.005**	-0.006***	-0.006***	0.012***
	(-2.547)	(-3.362)	(-3.049)	(5.827)
(1-R2)	0.022***	0.028***	0.031***	-0.140***
	(2.774)	(4.116)	(4.160)	(-11.302)
Q	-0.002	-0.001	-0.001	0.000
	(-1.339)	(-0.764)	(-0.639)	(0.032)
BA Spread	-0.318***	0.047	-0.040	0.772***
	(-4.695)	(0.844)	(-0.689)	(9.763)
BA Spread*Q	-0.083**	-0.147***	-0.154***	0.136***
	(-2.234)	(-5.072)	(-5.074)	(5.155)
Constant	0.221***	0.218***	0.216***	-0.313***
	(11.126)	(11.686)	(11.325)	(-8.878)
Observations	35366	33708	34020	35162
R-square	0.035	0.044	0.036	0.178
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes

Panel B	(1) Cash ETR	(2) Long-run Cash ETR1	(3) Long-run Cash ETR2	(4) Shelter Dummy
(1-R2)*Q	-0.006***	-0.009***	-0.009***	0.010***
	(-2.829)	(-5.073)	(-4.591)	(5.822)
(1-R2)	0.024***	0.034***	0.036***	-0.156***
	(3.373)	(5.215)	(5.228)	(-13.835)
Q	-0.001	-0.001	-0.001	0.001
	(-1.048)	(-0.822)	(-0.694)	(1.380)
Analyst Coverage	-0.003	-0.005**	-0.003	0.017***
	(-1.312)	(-2.406)	(-1.618)	(4.597)
Analyst Coverage*Q	-0.001	-0.000	-0.001	0.001
	(-0.848)	(-0.652)	(-1.154)	(0.701)
Constant	0.180***	0.182***	0.177***	-0.176***
	(12.273)	(13.122)	(12.389)	(-7.386)
Observations	42,854	39,255	39,965	42,926
R-square	0.032	0.041	0.033	0.168
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes

Table 7: Financial Constraints, Price Informativeness, and Tax Avoidance-to-Price Sensitivity

This table presents estimates of panel regressions to examine the impact of price informativeness on tax avoidance-to-price sensitivity after controlling for financial constraints. Panel A presents the regression results after controlling for *Altman Z*, which is modeled as 1.2*(working capital / total assets) + 1.4*(retained earnings / total assets) + 3.3*(earnings before interest and tax / total assets) + 0.6*(market value of equity / total liabilities) + 1.0*(sales / total assets), following Altman (1968). Panel B presents the regression results after controlling for *WW score*, which is modeled as -0.091*(cash flow/total assets) - 0.062 * positive dividend + 0.021 * (long-term debt/total assets) - 0.044 * (log of total assets) + 0.102 * industry sales growth-0.035 * firm sales growth, following White and Wu (2006). The dependent variables are tax avoidance measures including *Cash ETR*, *Long-run Cash ETR1*, *Long-run Cash ETR2*, and *Shelter Dummy*. The t-statistics are reported in parentheses. All specifications include year and firm fixed effects. Standard errors are clustered at the firm level. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. Descriptions of all the variables are provided in Appendix I.

Panel A	(1) Cash ETR	(2) Long-run Cash ETR1	(3) Long-run Cash ETR2	(4) Shelter Dummy
(1-R2)*Q	-0.010***	-0.009***	-0.007***	0.016***
	(-4.381)	(-4.468)	(-3.295)	(7.506)
(1-R2)	0.036***	0.036***	0.037***	-0.177***
	(4.684)	(5.250)	(4.950)	(-15.235)
Q	-0.002*	-0.002	-0.002	0.003***
	(-1.865)	(-1.433)	(-1.177)	(2.951)
Altman Z	0.001***	0.001***	0.001**	-0.004***
	(2.818)	(2.901)	(2.520)	(-9.430)
Altman Z*Q	0.000	-0.000*	-0.001***	0.001***
	(1.621)	(-1.885)	(-3.314)	(2.826)
Constant	0.173***	0.186***	0.183***	-0.183***
	(11.673)	(13.201)	(12.574)	(-7.608)
Observations	41,786	38,338	38,964	42,434
R-square	0.033	0.042	0.035	0.169
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes

Panel B	(1) Cash ETR	(2) Long-run Cash ETR1	(3) Long-run Cash ETR2	(4) Shelter Dummy
(1-R2)*Q	-0.003	-0.007***	-0.005**	0.009***
	(-1.380)	(-3.306)	(-2.232)	(4.336)
(1-R2)	0.019**	0.029***	0.028***	-0.158***
	(2.519)	(4.317)	(3.781)	(-13.537)
Q	-0.001	-0.000	0.000	0.001
	(-0.548)	(-0.102)	(0.269)	(1.283)
WW score	-0.027	0.046	-0.094***	0.096*
	(-0.759)	(1.425)	(-2.687)	(1.782)
WW score*Q	0.016**	0.016***	0.028***	-0.014*
	(2.547)	(2.877)	(4.721)	(-1.727)
Constant	0.185***	0.191***	0.185***	-0.198***
	(12.744)	(13.811)	(12.982)	(-8.268)
Observations	42,824	39,221	39,932	42,707
R-square	0.032	0.041	0.034	0.168
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes

Table 8: External Governance, Price Informativeness, and Tax Avoidance-to-Price Sensitivity

This table presents estimates of panel regressions to examine the impact of price informativeness on tax avoidance-to-price sensitivity after controlling institutional shareholder ownership. *Institutional Ownership* is the fraction of a firm's common equity owned by institutional investors. The dependent variables are tax avoidance measures including *Cash ETR*, *Long-run Cash ETR1*, *Long-run Cash ETR2*, and *Shelter Dummy*. The t-statistics are reported in parentheses. All specifications include year and firm fixed effects. Standard errors are clustered at the firm level. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. Descriptions of all the variables are provided in Appendix I.

	(1) Cash ETR	(2) Long-run Cash ETR1	(3) Long-run Cash ETR2	(4) Shelter Dummy
(1-R2)*Q	-0.003	-0.006**	-0.005**	0.007*
	(-1.211)	(-2.554)	(-2.172)	(1.941)
(1-R2)	0.018**	0.024***	0.033***	-0.137***
	(2.020)	(3.140)	(3.913)	(-9.051)
Q	0.000	-0.001	-0.000	0.005**
	(0.147)	(-0.764)	(-0.165)	(2.530)
Institutional Ownership	-0.005	-0.014*	0.009	0.119***
	(-0.602)	(-1.911)	(1.079)	(7.699)
Institutional Ownership*Q	-0.007**	-0.002	-0.005*	-0.006
	(-2.554)	(-1.001)	(-1.840)	(-1.480)
Constant	0.185***	0.214***	0.241***	-0.303***
	(10.085)	(12.279)	(13.326)	(-8.864)
Observations	29,761	27,032	27,501	27,481
R-square	0.036	0.050	0.043	0.196
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes

Table 9: Quintile Regressions of the Effect of Price Informativeness on Tax Avoidance-to-Price Sensitivity

This table presents estimates of quintile regressions to examine the impact of price informativeness on tax avoidance-to-price sensitivity. The sample is split into five groups based on the quintiles of (1-R2). The dependent variable is *Shelter Dummy*. The t-statistics are reported in parentheses. All specifications include year and firm fixed effects. Standard errors are clustered at the firm level. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. Descriptions of all the variables are provided in Appendix I.

	Lowest Quintile of (1-R2)				Highest Quintile of (1-R2)
	(1) Shelter Dummy	(2) Shelter Dummy	(3) Shelter Dummy	(4) Shelter Dummy	(5) Shelter Dummy
(1-R2)	-0.014	-0.065	0.057	-0.221	0.130
	(-0.489)	(-0.695)	(0.332)	(-0.923)	(0.454)
Q	-0.001	0.002	-0.000	-0.000	0.000
	(-0.451)	(0.665)	(-0.135)	(-0.068)	(0.068)
(1-R2)*Q	0.007	0.013*	0.013**	0.008***	0.005**
	(1.042)	(1.852)	(2.424)	(2.838)	(2.374)
Constant	-0.455***	-0.615***	-0.358**	0.077	-0.166
	(-10.542)	(-7.055)	(-2.251)	(0.332)	(-0.586)
Observations	10,664	8,456	8,036	7,882	7,888
R-square	0.196	0.183	0.096	0.048	0.027
Year FE	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes

Table 10: Heterogeneity Tests with Capital Intensity

This table presents estimates of panel regressions to examine the impact of price informativeness on tax avoidance-to-price sensitivity by firms with high capital intensity versus low capital intensity. The sample is split by the median value in capital intensity which is a firm's capital expenditure scaled by total book assets. The dependent variables are tax avoidance measures including *Cash ETR*, *Long-run Cash ETR1*, *Long-run Cash ETR2 (ext.)*, and *Shelter Dummy*. The t-statistics are reported in parentheses. All specifications include year and firm fixed effects. Standard errors are clustered at the firm level. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. Descriptions of all the variables are provided in Appendix I.

	High Capital Intensity				Low Capital Intensity			
	(1) Cash ETR	(2) Long-run Cash ETR1	(3) Long-run Cash ETR2	(4) Shelter Dummy	(5) Cash ETR	(6) Long-run Cash ETR1	(7) Long-run Cash ETR2	(8) Shelter Dummy
(1-R2)*Q	-0.008***	-0.012***	-0.012***	0.011***	-0.003	-0.006**	-0.006*	0.010***
	(-3.098)	(-5.161)	(-5.010)	(3.314)	(-0.902)	(-2.027)	(-1.812)	(4.573)
(1-R2)	0.033***	0.054***	0.055***	-0.155***	0.020*	0.019*	0.029***	-0.153***
	(3.266)	(6.202)	(5.821)	(-8.217)	(1.725)	(1.926)	(2.609)	(-10.193)
Q	-0.001	0.001	0.000	0.002	-0.005*	-0.004*	-0.004*	0.001
	(-0.373)	(0.412)	(0.197)	(1.140)	(-1.838)	(-1.783)	(-1.735)	(1.220)
Constant	0.199***	0.187***	0.166***	-0.270***	0.133***	0.166***	0.174***	-0.179***
	(9.963)	(10.447)	(8.830)	(-7.137)	(5.310)	(6.467)	(6.799)	(-4.973)
Observations	21,727	18,859	19,790	18,468	20,756	20,069	19,837	24,039
R-square	0.032	0.047	0.042	0.159	0.032	0.038	0.028	0.159
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Model	Model	Model	Model				
Chow test	(1)&(5)	(2)&(6)	(3)&(7)	(4)&(8)				
statistic	4.48	2.31	2.05	2.08				

Table 11: Heterogeneity Tests with Foreign Income

This table presents estimates of panel regressions to examine the impact of price informativeness on tax avoidance-to-price sensitivity by firms with foreign income versus without foreign income. The sample is split by *Foreign Income* which is a dummy variable that equals 1 if the firm has foreign income in year t and zero otherwise. The dependent variables are tax avoidance measures including *Cash ETR*, *Long-run Cash ETR1*, *Long-run Cash ETR2*, and *Shelter Dummy*. The t-statistics are reported in parentheses. All specifications include year and firm fixed effects. Standard errors are clustered at the firm level. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. Descriptions of all the variables are provided in Appendix I.

	Firms with Foreign Income				Firms without Foreign Income			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Cash ETR	Long-run Cash ETR1	Long-run Cash ETR2	Shelter Dummy	Cash ETR	Long-run Cash ETR1	Long-run Cash ETR2	Shelter Dummy
(1-R2)*Q	-0.005*	-0.009***	-0.002	0.016***	-0.007**	-0.009***	-0.012***	0.001
	(-1.701)	(-3.558)	(-0.509)	(3.725)	(-2.410)	(-3.683)	(-5.203)	(1.293)
(1-R2)	0.024**	0.040***	0.027***	-0.142***	0.017	0.015	0.028***	-0.027***
	(2.438)	(4.569)	(2.636)	(-7.939)	(1.443)	(1.510)	(2.798)	(-2.837)
Q	-0.003	0.001	-0.003	0.000	-0.000	-0.002	0.000	0.001
	(-1.344)	(0.413)	(-1.259)	(0.189)	(-0.181)	(-0.969)	(0.153)	(1.413)
Constant	0.229***	0.259***	0.289***	-0.322***	0.157***	0.163***	0.140***	-0.015
	(9.590)	(11.588)	(12.184)	(-6.871)	(7.609)	(8.615)	(7.439)	(-0.908)
Observations	21,235	19,572	19,718	20,223	21,619	19,683	20,247	22,703
R-square	0.055	0.073	0.061	0.233	0.024	0.026	0.027	0.031
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Chow test statistic	Model (1)&(5) 6.46	Model (2)&(6) 9.06	Model (3)&(7) 11.82	Model (4)&(8) 193.94				

Appendix I: Variable Definitions

Variables	Definitions
Dependent Variables	
Cash ETR	Effective tax rate, calculated by cash paid for income taxes scaled by the sum of pretax income (net of special items) over year t.
Long-run Cash ETR1	Long-term effective tax rate, calculated as five-year-centered moving sum of cash paid for income taxes over five years scaled by the sum of pretax income (net of special items) over the same period.
Long-run Cash ETR2	Long-term effective tax rate, calculated as the five-year-centered moving sum of cash paid for income taxes plus the excess tax benefit of stock options (Compustat variable TXBCO and TXBCOF) scaled by the sum of pretax income (net of special items) over the same period.
Shelter Dummy	A dummy variable equal to one if a firm's estimated shelter probability (estimated propensity of using tax shelters following Wilson [2009]) belongs to the top quartile, and zero otherwise. Shelter Prob. = -4.30 + 6.63 * book tax difference - 1.72 * (long-term debt scaled by total assets) + 0.66 * (log of total assets) + 2.26 * ROA + 1.62 * foreign income + 1.56 * (R&D expenditure/total assets).
Independent Variables	
(1-R2)	One minus R2 from regressing firm daily return on market and industry index over year t.
Q	Market value of equity plus book value of assets minus book value of equity, scaled by book value of assets.
Firm size	The natural logarithm of total book assets.
ROA	Firms' net income scaled by total book assets.
EBIT/Sale	Firms' EBIT scaled by total sales revenue.
Discretionary Accruals	The absolute value of discretionary accruals following Jones (1991).
Leverage	Firms' long-term and short-term debts scaled by total book assets.
Managerial Ability	Managerial ability score from Demerjian et al. (2012), computed using data envelopment analysis (DEA) where total sales is optimized using the vector of inputs including net PP&E, operating leases, R&D, purchased goodwill and intangibles, cost of goods sold, and SG&A. The DEA is optimized at the industry and year levels, and a firm efficiency score is computed. The firm efficiency score is then regressed on firm characteristics (size, market share, positive free cash flow, age, business segment concentration, a foreign currency indicator, and year indicators), and the residual from this regression is the managerial ability score. See Demerjian et al. (2012) for additional details.
BA Spread	Bid-ask spread calculated as (Ask-Bid)/(midpoint of ask and bid price) from CRSP.
Analyst Coverage	The number of analysts covering the firm in a given year t from I/B/E/S.
Altman Z	A financial constraint measure based on Altman (1968). Altman Z-Score is modeled as 1.2*(working capital / total assets) + 1.4*(retained earnings / total assets) + 3.3*(earnings before interest and tax / total assets) + 0.6*(market value of equity / total liabilities) + 1.0*(sales / total assets).
WW score	A financial constraint measure based on White and Wu (2006). WW score is modeled as -0.091*(cash flow/total assets) - 0.062 * positive dividend + 0.021 * (long-term debt/total assets) - 0.044 * (log of total assets) + 0.102 * industry

	sales growth-0.035 * firm sales growth. Positive dividend is an indicator that equals 1 if the firm pays cash dividends.
Institutional Ownership	The fraction of a firm's common stock owned by institutional investors from Thomson Reuters 13F Institutional Holdings.
Capital Intensity	Firm's capital expenditure scaled by total book assets.
Foreign Income	A dummy variable that equals 1 if the firm has foreign income in year t.