The Impact of Non-Income Taxes on Corporate Tax Avoidance:
An Examination of the Medical Device Excise Tax

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Acknowledgments: We would like to thank Jenny Brown, Kirsten Cook, Janet Huston, Michael Mayberry, and Casey Schwab, along with participants in the Tax Reading Group at Texas Tech University for their helpful comments.

Abstract

The Medical Device Excise Tax (MDET) enacted a 2.3 percent excise tax on the sale of certain medical devices. The tax was effective on sales beginning January 1, 2013 and ending on December 31, 2015 when the tax was temporarily suspended. We examine the impact of the MDET on medical device firms and their responses to the enactment and subsequent suspension of the tax. While the market and financial analysts perceived the enactment of the MDET as negative news, we are unable to determine a significantly negative impact to medical device firms' sales, profit margins, or overall profitability. However, we are able to demonstrate that medical device firms, specifically stronger firms, increased tax avoidance behavior following the enactment of the MDET. While there is a significant literature documenting determinants of income tax avoidance behavior, the impact of non-income taxes on income tax avoidance has not previously been documented in a US setting.

INTRODUCTION

The Medical Device Excise Tax (MDET), passed March 23, 2010 as part of the Affordable Care Act (ACA), enacted a 2.3 percent excise tax on the sale of certain medical devices. The tax was effective on sales beginning January 1, 2013 and ending on December 31, 2015 when the tax was temporarily suspended. Prior research demonstrates mixed evidence as to whether excise taxes are passed along to the consumer in the form of higher prices (Harris 1987; Peterson, Zeger, Remington and Anderson 1992; Stehr 2007) or at least partially fall upon the firm (Poterba 1996; Christensen et al. 2001; Jacob et al. 2019; Olbert and Werner 2019). Medical devices add further complication to this question because they are rarely purchased by the end consumer, rather by intermediaries such as hospitals, governments, insurance companies. Presuming medical device firms are unable to shift the excise tax to consumers, these firms would face eroding profit margins and potential financing constraints. While the MDET rate is relatively small (2.3%), prior literature demonstrates suggests the impact of consumption taxes can be larger than the impact of income taxes because they impact gross sales rather than net income (Desai et al. 2004; Robinson 2012; Dyreng and Maydew 2018). In efforts to fight the enactment of the MDET, firms suggested that responses to the tax would include cuts to research and development spending or reducing jobs (Gravelle and Lowry 2015). In this paper, we examine the impact of the MDET on medical device firms and their responses to the enactment and subsequent suspension of the tax.

We begin by examining both the perceived and actual impact of the tax on medical device firms. To gauge the perceived impact, we first examine the market response to news regarding the passage of the MDET. Our results demonstrate a negative reaction for medical device firms at the passage of the final §4191 regulations outlining the details of the MDET. We believe the negative market response to the passage of the final regulations suggest that the market perceived the MDET as a negative signal regarding future profitability for medical device manufacturers. Further supporting this notion, our results demonstrate a positive response for medical device firms upon news of the suspension of the MDET. These results are consistent with the findings of Hoopes, Thornock, and Williams (2016) in the context of sales taxes for e-tailers and the findings of Desai et al. (2004) demonstrating that foreign direct investment is more sensitive to non-income taxes than to income taxes. In addition to examining the stock market response to the enactment and suspension of the MDET, we also examine analysts' sales and earnings forecasts to determine analysts' perception of the act's impact on the medical device industry. Consistent with the stock market response, we find a significant decrease (increase) in analysts' sales and earnings forecasts following the enactment (suspension) of the MDET, further supporting the notion that the act was expected to negatively impact medical device firms.

To discourage the passage of the MDET, medical device firms argued that the tax would create financial constraints leading to reductions in employees and research and development spending (Gravelle and Lowry 2015). This expectation is consistent with a host of prior studies demonstrating that tax increases are associated with a reduction in employees, noting different elasticities depending on the type and magnitude of the tax (Ljungquist and Smolyansky 2018; Serrato and Zidar 2018; Giroud and Rauh 2019). We test this notion using a difference-in-differences approach comparing medical device firms to a control group of other firms in the medical industry from 2010 until 2017. However, we are unable to determine a significant decrease in total sales, gross margin, pretax income, or net income among medical device firms relative to control firms during the MDET period. Further, we examine whether this result for profitability was generated through cutting research and development, capital expenditures or the number of employees. Again, we are unable to find a significant decrease any of these expenditures among medical device firms during the MDET period. Thus, the MDET did not appear to have the negative connotations for profitability that medical device firms, financial analysts, and the broader market expected at the enactment of the tax. Generally, it appears that most of the increase in costs associated with the MDET was passed along to consumers, and demand for medical devices was relatively price inelastic.

After examining the expected and actual implications of the MDET, we examine whether the increased excise tax on the medical device industry impacted these firms' behavior with respect to tax avoidance. Two prior studies motivate the question of whether the MDET might lead to increased tax avoidance. First, Edwards, Schwab and Shevlin (2016) find that firms facing an increase in financial constraints, such as increased cost of external financing or difficulty in accessing external funding, increase cash tax planning to compensate for potential funding shortfalls. They suggest firms engage in tax planning over other cost-cutting techniques (e.g. cutting labor, capital expenditures, R&D, or advertising) because it is less likely to affect day-to-day business operations. While our initial findings suggest that the MDET did not constitute an actual constraint to medical device firms, it certainly appears that these firms expected that the tax would create financial constraints. Given that firms did not appear to engage in other cost-cutting techniques following the enactment of the MDET, we examine whether firms compensated for any potential funding shortfalls through cash tax planning.

Second, Kubick, Lynch, Mayberry, and Omer (2015) argue that firms with greater market power are insulated from competitive threats (e.g. MDET), giving these firms the ability to engage in greater tax avoidance. In the context of the MDET, while we find little change in margins and profitability in our entire sample, the MDET likely did not impact all medical device firms equally. Thus, through cross-sectional tests, we are able to further examine the implications of the Edwards et al. (2016) and the Kubick et al. (2015) studies. Specifically, to the extent that less powerful firms cannot pass along the excise tax to their customers, we expect them to be more financially constrained and increase cash tax avoidance (Edwards et al. 2016). However, more powerful medical device firms might have greater ability to engage in corporate tax avoidance, consistent with the findings of Kubick et al. (2015); to the extent that these firms' sales are not negatively impacted by the MDET, any additional tax avoidance would actually make these firms better off.

We examine multiple measures of tax avoidance, beginning with two standard measures of tax avoidance for profitable firms, GAAP effective tax rate (ETR) and Cash effective tax rate (Cash ETR). In sensitivity analyses, we use the measures from Henry and Sansing (2018), Δ and Δ/MVA,[1] as these measures allow us to examine loss firms in addition to profitable firms. Our tax avoidance tests demonstrate significant decreases in GAAP ETR and Cash ETR for medical device firms during the MDET period relative to pre-MDET period compared to control firms. Further, consistent with the findings of Kubick et al. (2015), these findings are stronger for firms with greater industry power. Thus, it appears that more powerful medical device firms were able to take the expectation of a financial constraint and use it to increase tax avoidance given their insulation from competitive threats. We are unable to find such evidence among either loss firms or those with relatively less industry power. Taken together, our findings suggest two conclusions: (1) the MDET did not cause a significant financial constraint on medical device firms precipitating cuts to capital spending or employment or requiring increases in corporate tax

[1] Δ is the difference between a firm's cash taxes paid, adjusted for tax refunds receivable, and the product of its pre-tax book income and the statutory tax rate.

avoidance (Edwards et al. 2016), and (2) for powerful medical device firms, the MDET appeared to create an opportunity to increase corporate tax avoidance leading to a net benefit for these firms. It is also important to note that in the period following the suspension of the MDET, we see no change in tax avoidance, suggesting that firms continued to use similar tax avoidance strategies even after the MDET was suspended.

While there is a highly developed literature stream regarding the determinants of tax avoidance, little empirical work has examined the impact of non-income taxes on corporate tax avoidance. We believe that the MDET provides a natural experiment to examine the impact of a non-income tax on corporate tax avoidance given that our sample period allows us to examine the impact of both the enactment and suspension of the tax. Our results demonstrate that, while the market and financial analysts were led to believe that the tax would affect medical device firms, there was little economic consequence associated with this tax. Generally, our findings suggest the tax was passed along to consumers. However, it also appears that medical device firms were able to use the perceived threat to increase tax avoidance strategies, lowering GAAP and Cash ETRs during the MDET period. Further, we find that medical device firms continued these tax avoidance strategies after the suspension of the MDET. Our results serve to inform both researchers and policymakers regarding the impact of non-income taxes on corporate tax avoidance. Specifically, given that the MDET suspension is set to end on December 31, 2019, these findings might inform debate on whether to extend the MDET suspension period or not.

The remainder of this paper proceeds as follows: in the next section, we provide background of the MDET, tax-avoidance literature and present hypotheses. Then, we detail our research design, including our sample-selection procedure and the empirical method used to test our hypotheses. Next, we present the results of our empirical tests. Finally, we discuss the implications of our results and provide avenues for future research.

Background and Hypothesis Development

MDET: Background

The Patient Protection and Affordable Care Act of 2010 (ACA), as amended by the Health Care and Education Reconciliation Act of 2010, became law March 23, 2010. To finance the ACA without adding to the budget deficit, the ACA (a) reduces Medicare and Medicaid payments to physicians and hospitals; (b) decreases subsidies to Medicare Advantage plans and streamlines pathways toward approval of follow-on biologics; and (c) increase taxes and fees for a wide range of healthcare-related -firms, among of which is the medical device firms.

Effective January 1, 2013, the 2.3 percent medical device excise tax (MDET) was imposed by Section 4191 of the Internal Revenue Code on the sale of certain medical devices (e.g., pacemakers, joint replacements, or surgical tools) by manufacturers, producers, and importers. The tax is levied on the manufacturer's wholesale price, requiring an estimate for manufacturers that double as distributors; however, items that are purchased by the public at retail prices for individual use, such as eyeglasses, contact lenses, and hearing aids are exempt from the tax along with devices manufactured for export (Gravelle and Lowry 2015).

The MDET was packaged in the ACA to help cover its cost. The main argument supporting the tax is that it only affected medical device companies that would be benefiting from increased demand for their products due to health insurance expansion through the ACA. Specifically, individuals would be more likely to purchase medical devices now that the purchases would be subsidized by health insurance (Gravelle and Lowry 2015). The MDET has become the watchword for many ACA critics intent on its repeal. Opponents of the MDET claim that it could have significant and negative consequences for the U.S. medical device firms (Furchtgott-Roth and Furchtgott-Roth 2011; Battelle Technology 2012; Ramlet, Book, and Zhong 2012; Kramer and Kesselheim 2013, Book 2017). Specifically, these studies suggest a reduction in research and development and significant job losses for employees of medical device firms. In addition, estimates of profit loss for device firms suggested negative stock market impacts for these firms (Gravelle and Lowry 2015).

From inception, Congress has taken strides to repeal the MDET. In 2012, the House passed H.R. 436, which would have repealed the MDET. The Senate voted on March 21, 2013, to repeal the MDET in a nonbinding budget resolution. The Consolidated Appropriations Act, 2016 (Pub. L. 114-113), signed into law on Dec. 18, 2015, included a two-year moratorium on the MDET imposed by Internal Revenue Code section 4191. The MDET was suspended during the period beginning on Jan. 1, 2016 and ending on Dec. 31, 2017. Furthermore, H.R. 195 (Pub. L. 115-120), signed into law on Jan. 22, 2018, extended the moratorium on the MDET for an additional two years, ending on Dec. 31, 2019.

Hypothesis Development

Prior literature related to the impact of excise taxes on firm performance focus generally on two main issues: (1) whether increases in excise taxes on cigarettes and alcohol (i.e. "sin" taxes) are able to discourage sales of these products through increased prices (Harris 1987; Peterson, Zeger, Remington and Anderson 1992; Stehr 2007), and (2) the extent to which these taxes are passed on to consumers. Findings on the second issue are relatively mixed; some work finds the excise tax is generally partially passed along to the consumer through increased prices (Peterson, Zeger, Remington and Anderson 1992; Stehr 2007), noting that Harris (1987) demonstrates overshifting of taxes, as price increases were greater than the increase in cigarette excise tax. However, other studies find that increased excise taxes at least partially fall upon the firm (Poterba 1996; Christensen et al. 2001; Jacob et al. 2019; Olbert and Werner 2019).

Additionally, sales taxes provide theoretical background on the potential impact of the MDET on medical device firms. Poterba (1996) finds that retail prices increase generally by the amount of the increase in sales taxes. Clearly, economic theory suggests that as prices increase, demand will decrease and the decrease depends on the demand elasticity of consumers. Fox and Campbell (1984) demonstrate that elasticity of sales tax collections varies depending on the strength of the economy, suggesting that demand elasticity is not constant over time. Hoopes et al. (2016) examine market and analyst reaction to e-tailers being forced to collect sales taxes for the first time, finding that both react negatively to these firms initiating sales tax collections. While their efforts motivate some of our tests, we argue that the MDET has far different implications relative to the initiation of sales tax collections for e-tailers for three reasons: (1) medical device firms are not giving up a competitive advantage relative to industry peers like e-tailers; (2) the party bearing the incidence of taxation for medical devices is unclear given the sales process in the industry (discussed further below), and (3) the MDET rate of 2.3% is significantly less than most states' sales tax rates.

While the impact of an excise tax is difficult to determine under normal circumstances, the nature of the medical industry creates additional challenges in determining the impact of the MDET. First, it is unclear the extent to which medical device firms can increase prices to shift the tax to end consumers because of the structure of the medical industry. Hospitals and insurance companies are generally the purchaser of medical devices rather than patients, and large buyers could have market power to resist manufacturers from shifting the MDET. Conversely, patent protection and limited product competition can give sellers pricing power

(Pauly and Burns 2008). Gravelle and Lowry (2015) further suggest that for technologically advanced products, there is no supply curve, rather an optimization of profits, meaning that some or all of the tax would be shifted to buyers. Second, there is no reason to expect that an excise tax would impact patient need for medical devices; in fact, patient demand could increase to the extent that the ACA allowed more individual patients access to medical devices. Thus, economic theory suggests that if a device company has little product competition, prices will increase to shift the cost of the MDET to the purchaser with little impact on demand.

Nonetheless, medical device firms consistently have lobbied against the MDET, suggesting that the tax increases consumer cost (lowering profits) and dissuades research and development in the medical technology field, potentially leading to a loss of jobs. A number of studies support their arguments, finding that tax increases are associated with reductions in employees (Ljungquist and Smolyansky 2018; Serrato and Zidar 2018; Giroud and Rauh 2019). Gravelle and Lowry (2015) estimate a profit decrease of approximately 0.7 percent of revenues if none of the tax was shifted to consumers. To the extent that the market perceives such a decrease in profits, the market should view the enactment of the MDET as a negative event for medical device firms. Regarding job losses, depending on assumptions used in calculating the expected impact of the MDET is estimated between 1,200 (Gravelle and Lowry 2015) and 43,000 (Furchtgott-Roth and Furchtgott-Roth 2011). These arguments motivate our first hypothesis examining both the market and analysts' initial perception of the impact of the MDET at its passage and the actual shock the MDET caused to the medical device industry.

H1: The MDET represents both a perceived and actual shock to the medical device industry.

Edwards et al. (2016) demonstrate that when firms face financial constraints, such as an increase in the cost of external financing or a decrease in the ability to access external funds, they increase tax avoidance behavior (tax planning) to generate additional internal funds. They suggest firms engage tax planning over other cost-cutting techniques (e.g. cutting labor, capital expenditures, R&D, or advertising) because it is less likely to affect day-to-day business operations. Thus, while Gravelle and Lowry (2015) argue that the negative impact of the MDET on firm profits is likely to lead to job loss, the Edwards et al. (2016) findings suggest that firms could use tax avoidance as a substitute for laying off employees or cutting investment spending. We expect any shock created by the MDET leads to increased tax avoidance because, to the extent that the MDET may erode profit margins, tax avoidance behavior enables firms to improve after-tax profitability.

There are several reasons why we might not find support for the expectation that the MDET leads to increased tax avoidance behavior. McGuire, Omer and Wilde (2014) find that as profitability becomes more volatile, the tax benefits of investing in tax planning can be reduced. Thus, the competitive shock created by the MDET might increase uncertainty regarding profitability, making firms less likely engage in tax avoidance strategies that might have to be reversed in the future (Scholes, Wolfson, Erickson, Maydew, and Shevlin 2020). Second, ex ante, it is unclear the extent to which the MDET will create a shock to firm profitability as those in the industry suggest. To the extent that medical device firms can shift the excise tax to their customers, the increase in after-tax profitability via income tax avoidance would not be needed.

Furthermore, Kubick et al. (2015) present a different expectation for tax avoidance, demonstrating that firms with greater market power are insulated from competitive threats, giving these firms the ability to engage in greater tax avoidance. Firms with product market power are more likely to pass the excise tax onto consumers, meaning the MDET would not create any of the anticipated negative effects. Thus, while these firms are not negatively impacted by the MDET, they might also engage in further tax avoidance following the enactment of the MDET. Taken together, we expect weaker medical device firms would increase tax avoidance behavior to improve perceived profitability lost based on the MDET (Edwards et al. 2016), whereas stronger firms would increase tax avoidance behavior based on the arguments of Kubick et al. (2015). This leads to our second hypothesis:

> ***H2: Medical device firms increase tax avoidance in response to the passage of the MDET.***

Empirical Method and Results

Sample Selection and Descriptive Statistics

Following Furchtgott-Roth and Furchtgott-Roth (2011), we identify medical device firms based on the North American Industry Coding System (NAICS) categories. While Furchtgott-Roth and Furchtgott-Roth (2011) use eight NAICS groups, we exclude Ophthalmic Goods Manufacturing (NAICS 339115) because the MDET does not apply to these firms and exclude Dental Laboratories (NAICS 339116) because we are unable to find comparable control group firms. Thus, our sample includes the six NAICS groups illustrated in Table 1. We obtain financial data for medical device firms from Compustat. The MDET was effective during the period from 2013 to 2015, but was suspended beginning January 1, 2016. We use a difference-in-difference (DID) analysis by estimating a propensity score model and matching each medical device firm observation with a firm with the same two-digit SIC industry codes (medical industry) using the nearest propensity score without replacement. In such a difference-in-differences (DID) analysis, the behavior of the control observations serves as counterfactual of the treatment observations. As a result, we are able to attribute the difference in behavior between the treatment observations and the control observations to the effect of the MDET. To investigate a difference-in-difference analysis on the effects of the MDET, our sample includes the observations from 2010 to 2017, which covers three years before the passage and two years following the suspension of the MDET. We exclude all 2018 observations because of the passage of the Tax Cuts and Jobs Act of 2017 that both decreased corporate tax rates from 35% to 21% and instituted a one-time transition tax on overseas profits; both of these provisions make comparability of tax rates incredibly difficult. Because all firms in these six NAICS classifications are defined as medical device firms in this study, it is impossible to identify control firms with the same NAICS numbers. Thus, we use the firms with the same two-digit SIC industry codes (medical industry) as the control group. The original dataset contain 2,147 medical device (treatment) firm-year observations, and 26,684 control firm-year. Because prior literature excludes negative pretax income firms when calculating tax avoidance (e.g. Dyreng et al. 2008, McGuire, Wang, and Wilson 2014), we eliminate 1,418 treatment firm observations and 7,179 control firm observations with negative pre-tax income. Next, we drop the 266 treatment firm observations and 16,921 control firm observation, respectively, lacking data needed to calculate variables. Based on the estimated propensity score, for each of the medical device firm-year observations, we identify one unique control firm observation had the closest propensity score as the treatment firm in the same industry and fiscal year. There are only a few treatment firm observations in each of the two-digit SIC classifications 26 and 67, meaning that neither can be predicted by the logistic model. Furthermore, we use a propensity score matching (PSM) procedure to construct a control sample (Dehejia and Wahba 2002; Li 2013), following the empirical approach used by Chen, Luo, Tang, and Tong (2015) to identify the *MedDev_firm* and non-*MedDev_firm* matched pairs. To ensure the matched observations are in the same industry and the same year, we hold the absolute difference of the estimated propensity score between the treatment firms and the control firms to be less than 0.5 (caliper matching),[2] and finally obtain 455 pairs of observations in the same industry and the fiscal year as the sample. Table 1 presents a breakdown of the sample.[3]

Table 2 presents the descriptive statistics of the variables used in the main analysis of this study. Generally, we find that control firms (other medical firms) are larger and have larger percentages of foreign income, but they are less capital intensive then treatment firms (medical device firms). Overall, we believe that the control sample represents a meaningful comparison group because, while for certain variables there are statistically significant differences across the control variables, the differences are generally not economically significant.

Perceived Impact of MDET

To test our first hypothesis, we first examine the market reaction to news of the enactment (suspension) of the MDET to determine whether the market perceives the tax as a negative effect on medical device firms. Following Gleason and Mills (2008), we develop Model (1) to investigate the market responses of the initial MDET passage, the passage of the final IRS regulations, and the suspension of the MDET.

$$CAR_{i,t} = \beta_0 + \beta_1 MedDev\_firm_i + \beta_2 BM_{i,t} + \beta_3 Size_{i,t} + \beta_4 Momentum_{i,t} + \varepsilon \qquad (1)$$

In the above model, *CAR* is the cumulative abnormal return for the firm for the three [five] trading-day window around the event day (day -1 [-2] to day +1 [+2]) minus the cumulative return for an equal-weighted portfolio of firms in the same CRSP size decile. We select two event days around the enactment of the MDET; the first is when the ACA (the MDET was packaged in the ACA) was passed on March 23rd, 2010, and the second is when the Final

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[2] In an untabulated analysis, we also relaxed the restriction of caliper<0.5 and obtained similar results.
[3] In sensitivity analysis, we use the same procedure to obtain a sample with loss firms. The sample includes 820 pairs of observations in the same industry and fiscal year.

IRS regulations were published on December 7th, 2012. The variable of interest, *MedDev_firm*, represents medical device firms, with the intercept representing matched healthcare firms that are not medical device firms. We expect negative coefficient for β_1 for the passage both of the MDET and the Final IRS Regulations, consistent with H1. Additionally, we examine December 18, 2015, the date that the MDET was suspended, expecting a positive coefficient for β_1 at the announcement of the MDET's suspension.

We include three control variables commonly related to returns in other finance and accounting capital market studies (e.g. Fama and French 1992; Jegadeesh and Titman 1993; Gleason and Mills 2008), the book-to-market ratio (*BM*), the natural log of total assets (*Size*) and cumulative size-adjusted returns for the six-month preceding the earnings announcement (*Momentum*). We include price momentum to control for any continuation of the market response to forecast revisions, earnings information leaks or other news prior to the earnings announcement.[4] We control for these variables to isolate the market response to earnings surprises to these well documented effects. All variables are defined in Appendix A.

Table 3 presents the *CAR* around the event days. First, at the passage of the MDET on March 23, 2010, the coefficients on *MedDev_firm* are insignificant.[5] When IRS published the Final §4191 Regulations on their website on December 7, 2012, the coefficients on *MedDev_firm* are negative and significant (-0.0113; p=0.009 within the 3-day window, and -0.0126; p=0.043 within the 5-day window). Moreover, we find positive coefficients for both CAR windows upon the suspension of the MDET. In untabulated sensitivity analyses with an extended sample including loss firms that needed to be dropped for our tax avoidance tests, our

[4] We also estimate the Model (1) with an additional control variable, abnormal accruals (*Ab_Accrual*) in sensitivity tests. The inferences are unchanged upon of the inclusion of abnormal accruals.
[5] While this result is not consistent with H1, in sensitivity analyses including loss observations, we are able to find a negative and significant market reaction for medical device firms at the passage of the tax.

results are significantly negative at the passage of the MDET and even stronger at the enactment of the final §4191 Regulations. Taken together, the results demonstrate that the market reacted negatively towards the MDET, suggesting that, consistent with H1, the market perceived the MDET to be detrimental to medical device firms.

Next, we examine the analyst forecasts around news of the enactment (suspension) of the MDET to determine whether analysts expect the MDET to negatively impact medical device firms. Following Hoopes, Thornock, and Williams (2016) and Clement (1999), we develop Model (2) to investigate analysts' sales and earnings forecast revisions on the initial MDET passage, the passage of the final IRS regulations, and the suspension of the MDET.

$$
\begin{aligned}
\%\Delta SaleForecast\ (\%\Delta EPSForecast) = {} & \beta_0 + \beta_1 MedDev\_firm_i + \beta_2 MDET\_Event_t \\
& + \beta_3 MedDev\_firm_i \times MDET\_Event_t + \beta_4 GeneralExperience_{i,t} \\
& + \beta_5 FirmSpecificExperience_{i,t} + \beta_6 SIZE_{i,t} + \beta_7 ROA_{i,t} + \beta_8 LEV_{i,t} \\
& + \beta_9 MTB_{i,t} + \varepsilon \qquad (2)
\end{aligned}
$$

The dependent variable, *%ΔSaleForecast (%ΔEPSForecast)*, is the percentage change from the analyst's previous forecast of future sales (EPS) for a given firm to the same analyst's current forecast of future sales (EPS) for that same fiscal quarter and firm. The control variables include general experience (*GeneralExperience*) level of the analyst and firm-specific (*FirmSpecificExperience*) level of the analyst, both of which could affect the accuracy of analysts' forecasts (Clement 1999). Additionally, we include firm size (*LogAsset),* return on assets (*ROA*), leverage (*LEV*), and market to book value (*MTB*), along with industry (*INDUSTRY)* fixed effects. All variables are defined in Appendix A. Our variable of interest in Model (2) is the interaction term of $MedDev\_firm_i \times MDET\_Event_t$. A negative coefficient for β_3 would suggust that analysts revised medical device firms' sales (EPS) forecasts downward following the medical device excise tax events relative to concurrent revsions of control firms' sales and earnings forecasts.

Table 4 presents the results of the test examining analyst forecast revisions following MDET events. Analysts' sales and earnings forecasts revisions are significantly negative following the passage of the MDET on March 23, 2010. The coefficients on *MedDev_firm×MDET_Event* are negative and significant (-0.0966; p=0.023 for *%ΔSaleForecast*, and -0.4344; p=0.041 for *%ΔEPSForecast*), suggesting that the MDET is associated with negative revisions in analysts' forecasts of future sales and earnings for medical device firms. Furthermore, we find positive coefficients for both *%ΔSaleForecast* and *%ΔEPSForecast* upon the suspension of the MDET. This result is consistent with the stock market response. Taken together, the results also demonstrate that analysts provide negative forecast revisions toward the passage of the MDET, and positive forecast revisions toward the suspension of the MDET, suggesting that analysts perceived the MDET to be detrimental to medical device firms.

Actual Impact of MDET

Following Yermack (1996), we develop Model (3) to investigate the actual effects of the MDET on firm performance.

$$Performance_{i,t} = \beta_0 + \beta_1 MedDev\_firm_i + \beta_2 MDET\_period_t + \beta_3 MedDev\_firm_i \times MDET\_period_t + \beta_4 SIZE_{i,t} + \beta_5 Segment_{i,t} + \beta_6 Performance_{i,t-1} + INDUSTRY_i + \varepsilon \quad (3)$$

In the above model, we test several performance measures of the medical device firms, including gross margin (*GM*), *Sales*, gross profit (*GP)*, price-cost margin (*PCM)* (Kubick et al. 2015), pre-tax income (*PTI*), and net income (*NI*). The control variables include firm size (*Size)*, the number of business segments *(Segment),* and performance in previous year (*Performance*$_{t-1}$). Our models also include industry (*INDUSTRY)* fixed effects. Our variable of interest in Model

(3) is the interaction term of $MedDev\_firm_i \times MDET\_period_t$ which tests the impact on medical device firms during the MDET period. A negative coefficient for β_3 would indicate a negative shock for medical device firms during the MDET period, consistent with H1.

In addition to examining the performance of medical device firms, we also examine whether firms alter specific expenditures in order to positively impact profitability, namely the number of employees (*Employees*), research and development exenses (*RND*) and capital expenditures (*Capex*). Medical device firms suggested they would cut jobs or other capital investments in response to the MDET (Gravelle and Lowry 2015). To test whether firms decreased employees, we utilize Model (3) above; however, we develop Model (4) following Biddle, Hilary, and Verdi (2009) to investigate the effects of the MDET on firm research and development and capital expenditures on actual shock:

$$\begin{aligned} RND_{i,t}\ (Capex_{i,t}) = {} & \beta_0 + \beta_1 MedDev\_firm_i + \beta_2 MDET\_period_t + \beta_3 MedDev\_firm_i \times MDET\_period_t \\ & + \beta_4\, LogAsset_{i,t} + \beta_5\, MTB_{i,t} + \beta_6\, SD\_CFO_{i,t} + B_7\, SD\_Sales_{i,t} + \beta_8\, Z\text{-}Score_{i,t} + \beta_9\, Tangibility_{i,t} \\ & + \beta_{10}\, K\text{-}structure_{i,t} + \beta_{11}\, Ind.\ K\text{-}structure_{i,t} + \beta_{12}\, CFOsale_{i,t} + \beta_{13}\, Slack_{i,t} + \beta_{14}\, Age_{i,t} \\ & + \beta_{15}\, OperatingCycle_{i,t} + \beta_{16}\, SD\_RND_{i,t}\ (SD\_Capex_{i,t}) + INDUSTRY_j + \varepsilon \qquad (4) \end{aligned}$$

The control variables include firm size (*LogAsset),* Market to Book value (*MTB*), standard deviation of cash follows form operations (*SD_CFO*), standard deviation of sales (*SD_Sales*), Z-score, ratio of PPE to total assets (*Tangibility*), *K-structure*, mean K-structure *(Ind. K-Structure*), ratio of cash flows from operations to sales (*CFOsale*), ratio of cash to PPE (*Slack*), dividend indicator (*Dividend*), firm age (*Age*), *Operating Cycle*, Loss indictor (*Loss*) and standard deviation of RND (*SD_RND*) or *Capex* (*SD_Capex*). Our models also include industry (*INDUSTRY)* fixed effects. All variables are defined in Appendix A. Our variable of interest in Model (4) remains the interaction term of $MedDev\_firm_i \times MDET\_period_t$. A negative coefficient for β_3 would indicate a negative shock for medical device firms during the MDET period.

Panels A and B of Table 5 presents the actual shock of the MDET on medical device firms using the DID analysis with the observations in 2012 and 2013 of the sample. We find that for all of our independent variables, these coefficents are insignificant, providing no evidence to suggest that the MDET negatively impacted medical device firms' performance as the market originally thought.[6] Further, we examine whether medical device firms appeared to preserve profitability through cutting jobs (*Employees*) or capital investments. Panel A of Table 5 demonstrates no significant changes in the number of employees, and Panel B finds no negative impact for either research and development or capital expenditures.

In untabulate sensitivity analyses, we also develop a firm-level analysis of the effects of the MDET on firm performance using only medical device firms, comparing the MDET period to the pre- and post-MDET periods; our inferences are unchanged under either specification. Further, we parse our sample in many ways, including a number of measures of profitability (e.g. gross margin, PCM, net income, etc.) calculated both before and after the enactment of the MDET to determine whether relatively weaker medical device firms saw a decline in profitability. In none of these specifications were we able to definitively determine a negative impact on profitability or any cuts to capital expenditures or employees. Taken together, this provides no empirical support for medical device firms' suggestion that the MDET created a shock that would lead to cutting jobs or capital investments (Gravelle and Lowry 2015).

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[6] We also estimate the effects of the MDET on medical device firms' gross margin, sales, gross profit, number of employees, profitiability, R&D expenses, and capital expenditures on actual shock after the MDET was effective at *the firm level* with the following models,

$$Performance_{i,t} = \beta_0 + \beta_1 MDET\_period_t + \beta_2 SIZE_{i,t} + \beta_3 Segment_{i,t} + \beta_4\ lag\_Performance_{i,t} + \beta_5 Performance_{i,t-1} + INDUSTRY_i + \varepsilon$$

$$RND_{i,t}\ (Capex_{i,t}) = \beta_0 + \beta_1 MDET\_period_t + \beta_2 LogAsset_{i,t} + \beta_3 MTB_{i,t} + \beta_4 SD\_CFO_{i,t} + B_5 SD\_Sales_{i,t} + \beta_6 Z\text{-}Score_{i,t} + \beta_7 Tangibility_{i,t} + \beta_8 K\text{-}structure_{i,t} + \beta_9 Ind.\ K\text{-}structure_{i,t} + \beta_{10} CFOsale_{i,t} + \beta_{11} Slack_{i,t} + \beta_{12} Agei,t + \beta_{13} OperatingCycle_{i,t} + \beta_{14} SD\_RND_{i,t}\ (SD\_Capex_{i,t}) + INDUSTRY_j + \varepsilon$$

We only keep the medical device firm observations in the sample. Thus, *MDET_period* is the variable of interest. The results are consistent with those in main DID analyses, i.e., medical device firm performance did not change significantly when the MDET was effective.

Tax Avoidance

Edwards et al. (2016) demonstrate that when facing financial constraints, firms increase tax planning in lieu of other forms of cost-cutting (e.g. labor, capital expenditures, R&D or advertising). Thus, we estimate the following model to determine whether medical device firms use tax avoidance to alleviate any potential profit shortfall associated with the enactment of the MDET:

$$\begin{aligned} TaxAvoid_{i,t} = {} & \beta_0 + \beta_1 MedDev\_firm_i + \beta_2 MDET\_period_t + \beta_3 MedDev\_firm_i \times MDET\_period_t \\ & + \beta_4 ROA_{i,t} + \beta_5 LEV_{i,t} + \beta_6 NOL_{i,t} + \beta_7 \Delta NOL_{i,t} + \beta_8 FORIN_{i,t} + \beta_9 CAPINT_{i,t} \\ & + \beta_{10} RND_{i,t} + \beta_{11} MTB_{i,t} + \beta_{12} SIZE_{i,t} + \beta_{13} LOSSINT_{i,t} \; (+ \beta_{14} SPI_{i,t}) + INDUSTRY_j \\ & + \varepsilon \qquad (5) \end{aligned}$$

We examine multiple measures of tax avoidance (*TaxAvoid*). Consistent with prior research, we examine two standard measures of tax avoidance for profitable firms, GAAP effective tax rate (ETR) and cash effective tax rate (Cash ETR). GAAP ETR presents tax avoidance activities that directly affect net income (Robinson et al. 2010) and are commonly used by both investors and executives as measures of a firm's tax burden and overall level of tax avoidance (Dyreng et al 2010; Rego 2003; Rego and Wilson 2012; Robinson et al. 2010), but GAAP ETR does not reflect tax avoidance activities by deferring cash taxes paid to later periods (Hanlon and Heitzman 2010). Unlike GAAP ETR, Cash ETR reflects any tax activity that reduces cash taxes paid in the current period (Dyreng et al 2008; McGuire, Wang, and Wilson 2014). Lower values of GAAP ETR and/or Cash ETR represent higher levels of tax avoidance.

For both GAAP ETR and Cash ETR, we utilize multiple specifications. First, following Dyreng et al. (2008) and McGuire, Wang, and Wilson (2014), we define *ETR1* as total tax expense (Compustat TXT) in year *t* divided by pre-tax book income (Compustat PI) less special items (Compustat SPI) in year *t*. Additionally, we define *Cash ETR1* as cash taxes paid (Compustat TXPD) in year *t* divided by pre-tax book income (Compustat PI) less special items

(Compustat SPI) in year *t*. Dyreng et al. (2017) do not adjust special items in the denominator but instead include special items as a control variable in the regression models. Thus, we define *ETR2* as total tax expense (Compustat TXT) in year *t* divided by pre-tax book income (Compustat PI) in year *t*. And we define *Cash ETR2* as cash taxes paid (Compustat TXPD) in year *t* divided by pre-tax book income (Compustat PI) in year *t*.

The difference-in-differences (DID) design includes indicator variables to test the differences in the dependent variables between treatment firms and control firms. The first indicator variable is *MedDev_firm*, a dummy variable that is coded "1" for treatment firms, i.e., medical device firms, and "0" for control firms. The second indicator variable is *MDET_period*, an indicator variable that is coded "1" for observations during the period from 2013 to 2015, and "0" otherwise. Following prior DID research (Meyer 1995), we include an interaction term, *MedDev_firm×MDET_period,* between *MedDev_firm* and *MDET_period*, and use this interaction term to test H2. The coefficient β_1 for *MedDev_Firm* captures the difference in tax avoidance between treatment and control firms in non-MDET periods. The coefficient β_2 for *MedDev_Period* captures the difference in tax avoidance between the MDET and non-MDET periods for control firms only. The coefficient β_3 for the interaction term is the difference-in-differences estimate, which captures the incremental difference in tax avoidance between the MDET period and the non-MDET period for treatment firms relative to control firms. Consistent with H2, a negative and significant β_3 coefficient would suggest that treatment firms report lower tax avoidance measures, including *ETRs*, and *Cash ETRs*, (higher tax avoidance) during the MDET periods than non-MDET periods relative to control firms.

We follow prior studies to select control variables (Mills, Erickson, and Maydew 1998; Rego 2003; Chen, Chen, Cheng, and Shevlin, 2010; McGuire, Wang, and Wilson 2014). These control variables include return on assets (*ROA*), leverage (*LEV*), capital intensity (*CAPINT*), research and development expenditures (*RND*), firm size (*SIZE*), and market-to-book ratio (*MTB*), an indicator variable for the presence of net operating loss carryforwards (*NOL*), the change in these carryforwards (Δ*NOL*), income from foreign operations (*FORINC*), and equity income (*EQINC*). We calculate these control variables using data from Compustat. Our models also include industry (*INDUSTRY)* fixed effects. When *ETR2* and *Cash ETR2* are the dependent variables, we add special items (*SPI*) as an additional control variable (Dyreng et al. 2017).

The results are reported in Table 6, with each panel representing the separate calculations of ETRs. The first two columns in each panel display comparisons between the pre-MDET period and the MDET period; the final two columns in each panel display comparisons between the MDET period and the post-MDETperiod. Consistent with H2, in the first two columns we find that the coefficients of the interaction, $MedDev\_firm_i \times MDET\_period_t$, are negative and significant (coefficient = -0.0426, $p = 0.046$ for *ETR1*; coefficient = -0.0515, $p = 0.067$ for *Cash ETR1;* coefficient = -0.0456, $p = 0.0047$ for *ETR2*; and coefficient = -0.0593, $p = 0.056$ for *Cash ETR2*, respectively). The results suggest that medical device firms engaged in more tax avoidance during the MDET period (2013-2015) than the pre-MDET period (2010-2012) relative to the corresponding control firms. However, the coefficients for the interaction are insignificant in the final two columns, indicating no sigificant change tax avoidance between the MDET period and the post-MDET period. This finding suggests that medical device firms continued using similar tax avoidance strategies even after the MDET was suspended.[7]

[7] We also estimate the effects of the MDET on medical device firms' GAAP ETRs and Cash ETRs at the *firm level* using the following model,

$$TaxAvoid_{i,t} = \beta_0 + \beta_1 MDET\_period_t + \beta_2 ROA_{i,t} + \beta_3 LEV_{i,t} + \beta_4 NOL_{i,t} + \beta_5 \Delta NOL_{i,t} + \beta_6 FORIN_{i,t} + \beta_7 CAPINT_{i,t} + \beta_8 RND_{i,t} + \beta_9 MTB_{i,t} + \beta_{10} SIZE_{i,t} + \beta_{11} LOSSINT_{i,t} \; (+ \beta_{14} SPI_{i,t}) + INDUSTRY_j + \varepsilon$$

We only keep the medical device firm observations in the sample. Thus, MDET_period is the variable of interest. The results are also consistent with those in main DID analyses. We further support that profitable medical device firms are more likely engage in tax avoidance during the MDET period than Pre-MDET period.

Given the Kubick et al. (2015) findings that stronger firms that are more insulated from competitive threats are more inclined to engage in tax avoidance, we examine whether strong MDET firms are more likely to engage in tax avoidance. We identify the pairs of observations (treatment firms and control firms) in 2012 and 2013, classifying strong firms as those with *PCM* (Kubick et al 2015) greater than the industry median *PCM* in 2012. Then, we re-estimate Model (5) with the strong, profitable medical device firm observations and paired observations. The results are presented in Table 7. The coefficients on the interaction, $MedDev\_firm_i \times MDET\_period_t$, are negative and significant (coefficient = -0.0439, p = 0.075 for *ETR1*; coefficient = -0.0404, p = 0.012 for *Cash ETR1*; coefficient = -0.0495, p = 0.055 for *ETR2*; and coefficient = -0.0427, p = 0.019 for *Cash ETR2*, respectively). Our findings are consistent with Kubick et al. (2015) that firms with great market power have the ability to pass the exerise tax onto consumer, and engage in greater tax avoidance.

In untabulated sensitivity analyses, we separately examined weaker firms but were unable to find a significant change in tax avoidance during the MDET period for these firms. Taking this result in conjunction with the findings in Table 4 demonstrating that the MDET did not create the expected shock to medical device firm profitability, we believe these results are also consistent with the findings of Edwards et al. (2016). Specifically, our results suggest that the MDET did not create a significant enough shock for medical device firms to precipitate a change in tax avoidance behavior among those most likely to be negatively impacted by the MDET.

SENSITIVITY ANALYSES

Henry and Sansing (2018) include loss firms and firms with negative current tax expense to study corporate tax avoidance with new empirical measures, arguing that deleting those observations results in truncation bias. These new measures allow us to examine loss firms in addition to profitable firms. Hereby, we create a sample including the loss firms using Henry and Sansing's measures, *CashETR_HS* and *Δ_CashETR_HS*, defined in Appendix A. In untabulated sensitivity analyses, we re-run our main analyses including loss firm-year observations. When we include loss observations in our CAR analyses, our inferences regarding the negative perception of the MDET becomes even stronger, as both the passage of the MDET and the publication of the regulations lead to significantly negative market reactions. While the market perceived the MDET as a shock to medical device firms, we are still unable to find a decrease in profitability for medical device firms upon the inclusion of loss firms, suggesting the MDET was not as large a shock as the market believed it to be.

Further, we employ DID analysis of tax avoidance between the MDET period and the Pre-MDET period using the sample with loss firms. The coefficients on the interaction, $MedDev\_firm_i \times MDET\_period_t$, are insignificant, suggesting that there is no significant tax avoidance change between the medical device firms and the corresponding control firms during the MDET period compared to the Pre-MDET period. Taken together, the results further support Kubick et al. (2015) that firms with product market power engage in greater tax avoidance. We further estimate the DID analysis of tax avoidance between the MDET period and the Post-MDET period. The results are similar with those in the main DID analysis, i.e., the coefficients on the interaction, $MedDev\_firm_i \times MDET\_period_t$, are insignificant.

CONCLUSION

In this paper, we examine the impact of the Medical Device Excise Tax, an excise tax on the sale of certain medical devices. We first examine the perceived and actual impact of the tax on the profitability of affected firms. Our results suggest that while the market and analysts initially expected the tax would negatively impact these firms, there were no significant changes to sales, margins, or overall profitability for these firms. We further examine whether this lack of impact on profitability is caused by cost-cutting efforts by these firms, including cuts to jobs or capital investments as the firms originally suggested (Gravelle and Lowry 2015). We find no evidence to support such claims.

In addition, we examine whether medical device firms appear to increase tax avoidance activity as a response to the MDET. Edwards et al. (2016) find that firms facing an increase in financial constraints, such as increased cost of external financing or difficulty in accessing external funding, increase cash tax planning to compensate for potential funding shortfalls. They suggest firms engage tax planning over other cost-cutting techniques (e.g. cutting labor, capital expenditures, R&D, or advertising) because it is less likely to affect day-to-day business operations. However, Kubick, Lynch, Mayberry, and Omer (2015) argue that firms with greater market power are insulated from competitive threats, giving these firms the ability to engage in greater tax avoidance. In the context of the MDET, medical device firms with greater product market power are more likely to pass the excise tax onto consumers, leaving them insulated from any competitive threats associated with the MDET. Thus, these firms would have greater ability to engage in tax avoidance during the MDET period. Given that the enactment and suspension of the MDET does not equally impact all medical device firms, we argue that the MDET provides a natural experiment to provide further support for these two theories of tax avoidance. Our results demonstrate that medical device firms increased tax avoidance activity during the MDET period, and this behavior was concentrated in the subset of stronger medical device firms, consistent with Kubick et al. (2015). Further, we find that medical device firms continued these tax avoidance strategies after the suspension of the MDET. We argue that our results are not in conflict with those of Edwards et al. (2016), rather it appears that the MDET did not create a large enough shock to precipitate additional tax avoidance.

While there is an abundance of literature examining tax avoidance behavior, little work has been done examining how increases in one form of tax (e.g. excise taxes) impacts tax avoidance in other areas (e.g. corporate income taxes) in the United States. Our results suggest this tax was generally passed along to consumers, but might also allow managers cover to increase tax avoidance behavior, most notably for stronger firms. Our results have the ability to further inform policymakers regarding the response to increases in non-income taxes. Given that the MDET suspension is set to end on December 31, 2019, these findings might inform debate on whether to extend the MDET suspension period.

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Table 1. Sample procedure

	Treatment obs		Control obs	
Firm-year observations during the period 2010 to 2017 (without		2,147		26,684
less observations with negative pre-tax income	(1,418)		(7,179)	
less observations missing information required to calculate variables	(266)		(16,921)	
		463		2,584
Propensity Score Matching (with caliper=0.5)		455		455

NAICA	Industry	Freq.	Percent	Cum.
325413	In-vitro diagnostic substance manufacturing	64	14.07	14.07
334510	Electromedical and Electrotherapeutic apparatus manufacturing	167	36.7	50.77
334517	Irradiation apparatus manufacturing	5	1.1	51.87
339112	Surgical and medical instrument manufacturing	103	22.64	74.51
339113	Surgical appliance and supplies manufacturing	94	20.66	95.16
339114	Dental equipment and supplies manufacturing	22	4.84	100
	Total	455	100	

	Fiscal Year	Treatment obs	Control obs	Total
pre_MDET	2010	57	57	114
	2011	59	59	118
	2012	63	63	126
MDET_period	2013	53	53	106
	2014	54	54	108
	2015	61	61	122
post_MDET	2016	55	55	110
	2017	53	53	106
Total		455	455	910

Table 2. Descriptive statistics

Variable	N	Treatment Firms p25	Treatment Firms Median	Treatment Firms p75	Treatment Firms Mean	Control Firms p25	Control Firms Median	Control Firms p75	Control Firms Mean	Diff. Mean	Diff. Median
ETR1	455	0.115	0.235	0.322	0.237	0.078	0.221	0.310	0.228	0.009	0.014
Cash_ETR1	455	0.076	0.182	0.295	0.230	0.108	0.207	0.326	0.262	-0.031 *	-0.024 *
ETR2	455	0.143	0.272	0.341	0.268	0.090	0.233	0.318	0.232	0.037 *	0.039 *
Cash_ETR2	455	0.090	0.219	0.338	0.272	0.120	0.228	0.355	0.282	-0.010	-0.009
ROA	455	0.047	0.095	0.173	0.126	0.054	0.092	0.133	0.105	0.021 ***	0.004
LEV	455	0.000	0.034	0.225	0.136	0.000	0.073	0.232	0.131	0.005	-0.039
NOL	455	1.000	1.000	1.000	0.833	1.000	1.000	1.000	0.890	-0.057 **	0.000 **
Δ*NOL*	455	-0.019	0.000	0.012	0.022	-0.013	0.000	0.010	-0.018	0.039	0.000
FORIN	455	0.000	0.008	0.051	0.028	0.000	0.029	0.065	0.038	-0.010 ***	-0.021 ***
CAPINT	455	0.084	0.122	0.189	0.149	0.063	0.104	0.165	0.131	0.018 ***	0.019 ***
EQINC	455	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000 ***	0.000 ***
RND	455	0.029	0.054	0.082	0.080	0.024	0.058	0.102	0.084	-0.003	-0.004
MTB	455	1.473	2.250	3.611	2.152	1.331	1.974	2.896	2.436	-0.285	0.276 ***
SIZE	455	4.541	6.077	7.365	5.946	4.791	6.458	8.231	6.358	-0.411 ***	-0.380 ***
LOSSINT	455	0.000	0.000	0.250	0.212	0.000	0.000	0.250	0.165	0.046 **	0.000 **
SPI	455	-0.014	-0.003	0.000	0.002	-0.009	-0.002	0.000	-0.004	0.006 *	-0.001

*, **, *** indicate significance at the 0.10, 0.05, and 0.01 level, respectively.

Table 3. Cumulative Abnormal Returns around Event Days

Model (1)	The Passage of MDET (March 23, 2010)		Final IRS Regulation (December 7, 2012)		The Suspension of MDET (December 18, 2015)	
VARIABLES	CAR1	CAR2	CAR1	CAR2	CAR1	CAR2
MedDev_firm	**-0.0020**	**-0.0007**	**-0.0113*****	**-0.0126****	**0.0155****	**0.0117***
	(0.773)	**(0.940)**	**(0.009)**	**(0.043)**	**(0.011)**	**(0.065)**
BM	-0.0327**	-0.0138	-0.0070	-0.0051	0.0118	0.0071
	(0.030)	(0.432)	(0.151)	(0.328)	(0.369)	(0.600)
Size	0.0008	0.0023	0.0022***	0.0023**	-0.0036**	-0.0019
	(0.654)	(0.216)	(0.002)	(0.015)	(0.031)	(0.270)
Momentum	0.0115	0.0130	0.0082	0.0526	0.0203	0.0204
	(0.626)	(0.610)	(0.767)	(0.314)	(0.283)	(0.300)
Constant	0.0136	-0.0047	-0.0039	-0.0076	0.0295*	0.0208
	(0.353)	(0.799)	(0.567)	(0.409)	(0.054)	(0.188)
Observations	86	86	126	126	94	94
Adjusted R-squared	0.021	0.027	0.103	0.068	0.117	0.027

*, **, *** indicate significance at the 0.10, 0.05, and 0.01 level, respectively.
All variables are defined in Appendix A.
The results are reported in 2-tailed p-values.
Standard errors are robust, and clustered by firms.
All continuous variables are winsorized at the 1 and 99% level.

Table 4. Analyst Forecasts for Percentage Changes in Sales and EPS on the Events

Model (2)	The Passage of MDET (March 23, 2010)		Final IRS Regulation (December 7, 2012)		The Suspension of MDET (December 18, 2015)	
VARIABLES	%ΔSaleForecast	%ΔEPSForecast	%ΔSaleForecast	%ΔEPSForecast	%ΔSaleForecast	%ΔEPSForecast
MedDev_firm	-0.0307	-0.0251	0.0392**	-0.0617	0.0155**	0.0312*
	(0.166)	(0.823)	(0.012)	(0.483)	(0.048)	(0.084)
MDET_Event	0.0802**	0.3883**	-0.0642***	-0.2324*	-0.0454***	-0.0524**
	(0.010)	(0.012)	(0.003)	(0.054)	(0.000)	(0.038)
MedDev_firm × MDET_Event	**-0.0966****	**-0.4344****	**0.0438**	**0.1636**	**0.0317****	**0.0606***
	(0.023)	**(0.041)**	**(0.148)**	**(0.340)**	**(0.037)**	**(0.081)**
GeneralExperience	-0.0017	-0.0101	0.0000	-0.0114	0.0003	0.0021
	(0.302)	(0.268)	(0.987)	(0.193)	(0.574)	(0.145)
FirmSpecificExperience	0.0064***	0.0154	0.0027*	0.0003	-0.0001	-0.0040**
	(0.004)	(0.153)	(0.082)	(0.977)	(0.903)	(0.022)
Size	0.0047	0.0201	0.0142***	-0.0490**	0.0041*	0.0094*
	(0.544)	(0.605)	(0.001)	(0.050)	(0.073)	(0.075)
ROA	0.4150***	2.1730***	0.1619**	0.1697	0.0317	0.1843*
	(0.001)	(0.000)	(0.050)	(0.718)	(0.444)	(0.053)
LEV	-0.1243	0.0390	-0.0421	0.5964**	-0.0028	0.0192
	(0.125)	(0.923)	(0.337)	(0.014)	(0.871)	(0.630)
MTB	-0.0115	-0.0522	0.0004	0.0027	0.0007*	0.0016*
	(0.111)	(0.141)	(0.611)	(0.576)	(0.083)	(0.096)
Constant	-0.0455	-0.2915	-0.1751***	0.5184**	-0.0730***	-0.1699***
	(0.397)	(0.294)	(0.000)	(0.017)	(0.001)	(0.001)
Observations	270	270	276	276	300	300
Adjusted R-squared	0.128	0.069	0.109	0.017	0.082	0.060

*, **, *** indicate significance at the 0.10, 0.05, and 0.01 level, respectively.
All variables are defined in Appendix A.
The results are reported in 2-tailed p-values.
Standard errors are robust, and clustered by firms.
All continuous variables are winsorized at the 1 and 99% level.

Table 5 Panel A: DID analyses based on actual shock 2012-2013

Model (3)

VARIABLES	GM	Sales	GP	PCM	PTI	NI	Employees
MedDev_firm	0.0674**	-0.1144*	0.0102	0.0004**	0.0136	0.0071	0.4232
	(0.035)	(0.084)	(0.737)	(0.047)	(0.282)	(0.553)	(0.845)
MDET_period	0.0059	-0.0908	0.0112	0.0005	-0.0050	-0.0098	-1.1478
	(0.789)	(0.168)	(0.745)	(0.351)	(0.602)	(0.265)	(0.279)
MedDev_firm × MDET_period	**-0.0206**	**0.0650**	**-0.0532**	**-0.0005**	**-0.0014**	**0.0185**	**-0.7537**
	(0.484)	**(0.397)**	**(0.190)**	**(0.288)**	**(0.939)**	**(0.273)**	**(0.712)**
Segment	-0.0050***	0.0066**	0.0010	0.0000	0.0011	-0.0000	0.2640
	(0.010)	(0.020)	(0.365)	(0.675)	(0.141)	(0.970)	(0.435)
Size	-0.0010	-0.0540***	-0.0214***	0.0000	-0.0057	-0.0022	1.2244**
	(0.886)	(0.004)	(0.005)	(0.599)	(0.110)	(0.482)	(0.025)
lag_GM	0.2429***						
	(0.000)						
lag_Sales		0.8452***					
		(0.000)					
lag_GP			0.8853***				
			(0.000)				
lag_PCM				0.9213***			
				(0.000)			
lag_PTI					0.3361***		
					(0.003)		
lag_NI						0.1104**	
						(0.038)	
lag_Employees							0.8168***
							(0.000)
Constant	0.4849***	0.5586***	0.1924**	-0.0008	0.0888***	0.0557***	-5.6085*
	(0.000)	(0.004)	(0.012)	(0.113)	(0.000)	(0.006)	(0.098)
Observations	232	232	232	168	232	232	232
Adjusted R-squared	0.214	0.476	0.510	0.586	0.110	0.026	0.667
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes

*, **, *** indicate significance at the 0.10, 0.05, and 0.01 level, respectively.

All variables are defined in Appendix A.

The results are reported in 2-tailed p-values.

Standard errors are robust, and clustered by firms.

All continuous variables are winsorized at the 1 and 99% level.

Table 5 Panel B: DID analyses based on actual shock 2012-2013 (Cont'd)

Model (4)

VARIABLES	(1) R&D	(2) Capex
MedDev_firm	-5.6628	-3.0586
	(0.395)	(0.616)
MDET_period	6.5518	2.1820
	(0.498)	(0.702)
MedDev_firm × MDET_period	**-13.3369**	**-9.2851**
	(0.350)	**(0.284)**
LogAsset	-5.0518	-1.3674
	(0.147)	(0.572)
MTB	4.8012	4.1965*
	(0.122)	(0.063)
SD_CFO	-137.4930	80.5066
	(0.422)	(0.320)
SD_Sales	38.3398	-83.9532**
	(0.447)	(0.014)
Z-Score	-2.1456	9.0584
	(0.612)	(0.123)
Tangibility	39.3640	-16.7917
	(0.382)	(0.667)
K-structure	49.4014	31.6392
	(0.369)	(0.635)
Ind. K-structure	-173.1493	-73.5366
	(0.192)	(0.523)
CFOsale	-9.8428	5.1852
	(0.679)	(0.886)
Slack	0.6793	1.4079*
	(0.564)	(0.059)
Dividend	12.1255	-5.2463
	(0.109)	(0.294)
Age	4.1087	-8.5938**
	(0.263)	(0.029)
OperatingCycle	0.2191	-0.0700
	(0.436)	(0.729)
Loss	0.3009	-17.3441
	(0.976)	(0.141)
SD_R&D	3.6760	
	(0.184)	
SD_Capex		0.1326
		(0.502)
Constant	1.1220	64.8913**
	(0.957)	(0.018)
Observations	232	232
Adjusted R-squared	0.377	0.209
Industry	Yes	Yes

*, **, *** indicate significance at the 0.10, 0.05, and 0.01 level, respectively.
All variables are defined in Appendix A.
The results are reported in 2-tailed p-values.
Standard errors are robust, and clustered by firms.
All continuous variables are winsorized at the 1 and 99% level.

Table 6. DID Analysis of Tax Avoidance

Model (5)	Pre MDET vs MDET period		MDET period vs Post MDET	
	(1)	(2)	(3)	(4)
VARIABLES	ETR1	CASH_ETR1	ETR1	CASH_ETR1
MedDev_firm	0.0219	-0.0078	0.0208	-0.0681*
	(0.298)	(0.780)	(0.511)	(0.064)
MDET_period	-0.0019	-0.0210	-0.0238	-0.0115
	(0.951)	(0.516)	(0.501)	(0.773)
MedDev_firm × MDET_period	**-0.0426****	**-0.0515***	**-0.0415**	**0.0081**
	(0.046)	**(0.067)**	**(0.108)**	**(0.411)**
ROA	0.0717	0.1245	0.1272	0.1079
	(0.471)	(0.385)	(0.323)	(0.507)
LEV	-0.0104	0.1679***	-0.1521***	0.0829
	(0.814)	(0.007)	(0.001)	(0.293)
NOL	-0.0490*	-0.0751**	-0.0644**	-0.1004**
	(0.053)	(0.030)	(0.048)	(0.015)
Δ*NOL*	-0.0085	-0.0030	-0.0070	-0.0043
	(0.103)	(0.852)	(0.397)	(0.838)
FORIN	-0.5949***	-0.4076*	-0.2291	-0.4395
	(0.003)	(0.062)	(0.407)	(0.139)
CAPINT	-0.0004	-0.2548***	0.0844	-0.2060
	(0.995)	(0.007)	(0.428)	(0.123)
EQINC	-0.7948	-4.2570	-10.6146	-5.5486
	(0.880)	(0.525)	(0.217)	(0.571)
RND	-0.1253**	0.1154	0.0529	0.0899
	(0.015)	(0.369)	(0.593)	(0.644)
MTB	0.0001	-0.0041**	0.0004	-0.0028
	(0.933)	(0.043)	(0.568)	(0.223)
SIZE	0.0012	-0.0130	0.0079	-0.0018
	(0.849)	(0.148)	(0.265)	(0.877)
LOSSINT	-0.1305***	-0.1038*	-0.1328***	-0.0265
	(0.000)	(0.064)	(0.009)	(0.700)
Constant	0.3075***	0.4564***	0.3115***	0.4390***
	(0.000)	(0.000)	(0.000)	(0.000)
Observations	694	694	552	552
Adjusted R-squared	0.086	0.097	0.076	0.047
Industry	Yes	Yes	Yes	Yes

*, **, *** indicate significance at the 0.10, 0.05, and 0.01 level, respectively.
All variables are defined in Appendix A.
One-tailed p-values appear in parentheses for the variable of interest (the interaction).
Two-tailed p-values for other variables.
Standard errors are robust, and clustered by firms.
All continuous variables are winsorized at the 1 and 99% level.

Table 6. DID Analysis of Tax Avoidance (Cont'd)

Model (5)	Pre MDET vs MDET period		MDET period vs Post MDET	
	(1)	(2)	(3)	(4)
VARIABLES	ETR2	CASH_ETR2	ETR2	CASH_ETR2
MedDev_firm	0.0581**	0.0207	0.0559*	-0.0063
	(0.011)	(0.483)	(0.072)	(0.877)
MDET_period	0.0145	-0.0008	-0.0066	0.0087
	(0.585)	(0.980)	(0.843)	(0.833)
MedDev_firm × MDET_period	**-0.0456****	**-0.0593***	**-0.0438**	**-0.0332**
	(0.0047)	**(0.056)**	**(0.108)**	**(0.202)**
ROA	-0.1143	-0.3468**	-0.1322	-0.3188
	(0.284)	(0.023)	(0.275)	(0.133)
LEV	-0.0088	0.2404***	-0.2108***	0.1890*
	(0.829)	(0.001)	(0.000)	(0.056)
NOL	-0.0377	-0.0572*	-0.0469	-0.0855**
	(0.153)	(0.099)	(0.151)	(0.044)
Δ*NOL*	-0.0048	0.0077	-0.0034	0.0077
	(0.485)	(0.630)	(0.655)	(0.751)
FORIN	-0.5880***	-0.3072	-0.4749*	-0.5752**
	(0.006)	(0.209)	(0.053)	(0.041)
CAPINT	0.0170	-0.2333**	0.2034*	-0.2174
	(0.815)	(0.021)	(0.068)	(0.159)
EQINC	-6.0178	-4.2895	3.6395	6.7609
	(0.189)	(0.579)	(0.496)	(0.494)
RND	-0.1011*	0.2659**	0.1538	0.1752
	(0.057)	(0.032)	(0.177)	(0.383)
MTB	0.0007	-0.0047*	0.0003	-0.0028
	(0.335)	(0.063)	(0.719)	(0.294)
SIZE	0.0032	-0.0144	0.0090	-0.0065
	(0.592)	(0.127)	(0.163)	(0.572)
LOSSINT	-0.0975**	-0.1434**	-0.1079**	-0.0515
	(0.014)	(0.013)	(0.044)	(0.491)
SPI	-0.4225**	0.2531	-0.3197	-0.3829
	(0.022)	(0.520)	(0.141)	(0.323)
Constant	0.2655***	0.4707***	0.2726***	0.4884***
	(0.000)	(0.000)	(0.000)	(0.000)
Observations	694	694	552	552
Adjusted R-squared	0.096	0.101	0.077	0.067
Industry	Yes	Yes	Yes	Yes

*, **, *** indicate significance at the 0.10, 0.05, and 0.01 level, respectively.
All variables are defined in Appendix A.
One-tailed p-values appear in parentheses for the variable of interest (the interaction).
Two-tailed p-values for other variables.
Standard errors are robust, and clustered by firms.
All continuous variables are winsorized at the 1 and 99% level.

Table 7. DID Analysis of Tax Avoidance using strong firms in 2012 and 2013

Model (5)	(1)	(2)	(3)	(4)
VARIABLES	ETR1	CASH_ETR1	ETR2	CASH_ETR2
MedDev_firm	0.0363	-0.0507	0.0376	-0.0600
	(0.164)	(0.156)	(0.167)	(0.152)
MDET_period	-0.0044	-0.0379	-0.0072	-0.0300
	(0.853)	(0.307)	(0.775)	(0.487)
MedDev_firm × MDET_period	**-0.0439***	**-0.0404****	**-0.0495***	**-0.0427****
	(0.075)	**(0.012)**	**(0.055)**	**(0.019)**
ROA	0.7938***	0.2862	0.6989***	0.0429
	(0.000)	(0.159)	(0.000)	(0.862)
LEV	-0.0403	-0.0555	-0.0112	0.0103
	(0.666)	(0.655)	(0.905)	(0.943)
NOL	0.0377	-0.0791*	0.0551*	-0.0766
	(0.321)	(0.086)	(0.087)	(0.161)
Δ*NOL*	-0.0220	0.0985	0.0698	0.1838
	(0.937)	(0.737)	(0.821)	(0.591)
FORIN	-0.4131	0.1297	-0.3473	0.1256
	(0.137)	(0.677)	(0.221)	(0.730)
CAPINT	-0.1903	0.0541	-0.2080*	0.0746
	(0.114)	(0.691)	(0.066)	(0.640)
EQINC	-2.5123	15.2543	-3.1028	13.6983
	(0.611)	(0.183)	(0.513)	(0.304)
RND	-0.1085	-0.2926	-0.0403	-0.0381
	(0.668)	(0.401)	(0.892)	(0.925)
MTB	0.0121*	-0.0105	0.0131**	-0.0128
	(0.081)	(0.364)	(0.045)	(0.342)
SIZE	-0.0204**	-0.0026	-0.0243***	-0.0026
	(0.036)	(0.820)	(0.010)	(0.842)
LOSSINT	-0.1378**	-0.3122***	-0.1373*	-0.3638***
	(0.047)	(0.001)	(0.087)	(0.001)
SPI			-0.5429	-0.4391
			(0.241)	(0.576)
Constant	0.2115**	0.3540***	0.2266***	0.3364***
	(0.015)	(0.000)	(0.010)	(0.000)
Observations	88	88	88	88
Adjusted R-squared	0.509	0.234	0.427	0.104
Industry	Yes	Yes	Yes	Yes

*, **, *** indicate significance at the 0.10, 0.05, and 0.01 level, respectively.
All variables are defined in Appendix A.
One-tailed p-values appear in parentheses for the variable of interest (MedDev_Period).
Two-tailed p-values for other variables.
Standard errors are robust, and clustered by firms.
All continuous variables are winsorized at the 1 and 99% level.

Appendix A. Variable Definitions

<u>Variables of Interest</u>	
MedDev_firm × MDET_period	interaction of MedDev_firm and MDET_period
MedDev_firm × MDET_Event	interaction of MedDev_firm and MDET_Event
<u>Dependent Variables in H1</u>	
CAR1	cumulative abnormal return for the firm for the three trading-day window around the event day (day -1 to day +1) minus the cumulative return for an equal-weighted portfolio of firms in the same CRSP size decile.
CAR2	cumulative abnormal return for the firm for the five trading-day window around the event day (day -2 to day +2) minus the cumulative return for an equal-weighted portfolio of firms in the same CRSP size decile.
%ΔSaleForecast	the percentage change from the analyst's prvious forecast of future sales for a given firm to the same analyst's current forecast of future sales for that same fiscal quarter and firm
%ΔEPSForecast	the percentage change from the analyst's prvious forecast of future EPS for a given firm to the same analyst's current forecast of future EPS for that same fiscal quarter and firm
GM	Sales (Compustat SALE) less cost of good sold (Compustat COGS) divided by Sales (Compustat SALE)
Sales	Sales (Compustat SALE) divided by total assets (Compustat AT)
GP	Gross profit (Compustat GP) divided by total assets (Compustat AT)
PCM	Price-cost margin: the operating profit (Compustat SALE - COGS - XSGA) divided by Sales (Compustat SALE) minus the value-weighted (based on sales) industry average (based on two-digit SIC).
Employees	Employees (Compustat EMP) divided by total assets (Compustat AT)
PTI	Pretax Income (Compustat PI) divided by total assets (Compustat AT)
NI	Net Income (Compustat NI) divided by total assets (Compustat AT)
R&D	research and development expenditure (Compustat XRD) multiplied by 100 and divided by lagged total assets (Compustat AT)
Capex	capital expenditure (Compustat CAPX) multiplied by 100 and divided by lagged PPE (Compustat PPENT)

<u>Dependent Variables in H2</u>	
ETR1	total income tax (Compustat TXT) divided by pre-tax book income (Compustat PI) less special items (Compustat SPI)
Cash_ETR1	cash taxed paid (Compustat TXT) divided by pre-tax book income (Compustat PI) less special items (Compustat SPI)
ETR2	total income tax (Compustat TXT) divided by pre-tax book income (Compustat PI)
Cash_ETR2	cash taxed paid (Compustat TXT) divided by pre-tax book income (Compustat PI)
<u>Control Variables</u>	
MedDev_firm	indicator variable equal to 1 if the observation is a medical device firm, 0 otherwise
MDET_period	indicator variable equal to 1 if the observation is within year 2013 to 2015, 0 otherwise
MDET_Event	indicator variable equal to 1 for the first forecast revision that is released following one of the medical device exercise tax (MDET) event
BM	Common shareholders equity (Compustat CEQ) divided by Market value of comment stock at the end of the fiscal year (Compustat CASHO*PRCC_F)
Momentum	cumulative size-adjusted returns for the six-month proceeding the earnings announcement from Eventus
Lag_GM	GM in year$_{t-1}$
lag_Sales	Sales in year$_{t-1}$
Lag_GP	GP in year$_{t-1}$
lag_PCM	PCM in year$_{t-1}$
Lag_Employees	Employees in year$_{t-1}$
Lag_PTI	PTI in year$_{t-1}$
Lag_NI	NI in year$_{t-1}$
Segment	Number of Business Segment (Compustat Segment SID)
LogAsset	the log of total assets (Compustat AT)
SD_CFO	standard deviation of cash flows from operations (Compustat OANCF) divided by average total assets (Compustat AT) from quarters t-5 to t-1
SD_Sales	standard deviation of sales (Compustat SALE) divided by average total assets (Compustat AT) from quarters t-5 to t-1
Z-Score	(3.3 × (Compustat PI) + (Compustat SALE) + 0.25×(Compustat RE) + 0.5×(Compustat AT - LCT))/AT
Tangibility	the ratio of PPE (Compustat PPENT) to total assets (Compustat AT)
K-structure	the ratio of long-term debt (Compustat DLTT) to the sum of long-term debt (Compustat DLTT) + market value of equity (Compustat CSHO × Compustat PRCC_F).
Ind. K-structure	mean K-structure for firms in the same SIC 3-digit industry
CFOsale	the ratio of cash flows from operating's (Compustat OANCF) to sales (Compustat SALE)
Slack	the ratio of cash (Compustat CHE) to PPE (Compustat PPENT)

Dividend	indicator variable equal to 1 if the firm paid a dividend (i.e., if Compustat DV>0), 0 otherwise
Age	the difference between the first year when the firm appears in CRSP and the current year
OperatingCycle	the log of receivables (Compustat RECT) to sales (Compustat SALE) plus inventory to COGS (Compustat INVT/COGS)+1) multiplied 90.
Loss	indicator variable equal to 1if net income before extra ordinary items (Compustat IB) is negative, 0 otherwise
SD_R&D	standard deviation of research and development expense (Compustat XRD) multiplied by 100 and divided by total assets at the beginning of the quarter (Compustat AT) from quarters t-5 to t-1
SD_Capex	standard deviation of capital expenditure (Compustat CAPX) multiplied by 100 and divided by lagged PPE (Compustat PPENT) from quarters t-5 to t-1
ROA	pre-tax income (Compustat PI) less extraordinary items (Compustat XI) divided by total assets at the beginning of the year (Compustat AT)
LEV	long-term debt (Compustat DLTT) divided by total assets at the beginning of the year (Compustat AT)
NOL	indicator variable equal to 1 if there is a tax loss carryforward (Compustat TLCF is positive) during year t, 0 otherwise;
Δ*NOL*	change in tax-loss carryforward (Compustat TLCF) form year t-1 to t scaled by total assets at the beginning of the year (Compustat AT);
FORIN	pre-tax foreign income for year t (Compustat PIFO) scaled by total assets at the beginning of the year (Compustat AT). Missing values of pre-tax foreign income are set to 0.
CAPINT	net PPE (Compustat PPENT) divided by total assets at the beginning of the year (Compustat AT)
EQINC	equity income for year t (Compustat ESUB) scaled by total assets at the beginning of the year (Compustat AT). Missing values of equity income are set to 0.
RND	research and development expense (Compustat XRD) divided by total assets at the beginning of the year (Compustat AT)
MTB	market-to-book ratio at the beginning of the year, measured as market value of equity (Compustat PRCC_F × CSHO) divided by book value of equity (Compustat CE)
SIZE	natural logarithm of total assets at the beginning of the year (Compustat AT)
LOSSINT	loss intensity over the previous four years, measured as the number of years each firm has negative book income from year t-4 to year t-1 (scaled to range from 0 to 1)
SPI	special items (Compustat SPI) divided by total assets (Compustat AT)
FirmSpecificExperience	number of years through year t for which analyst i supplied at least one forecast during the first 11 months of the year for firm j
GeneralExperience	number of years for which analyst i supplied at least one forecast during the first 11 months of the year through year t
INDUSTRY	Indicator variables for two-digit SIC industry fixed effects

Additional Dependent Variables in Sensitivity Analyses

CashETR_HS	(Cash Taxes Paid (Compustat TXPD) less Refunds Receivable (Compustat TXR)) less (Pretax Income (Compustat PI)*Statutory Rate (0.35)) divided by Market Value Assests (AT + ((PRCC_F*CASHO)-SEQ)
Δ_CashETR_HS	The numerator of *CashETR_HS* less the lag of the numerator of *CashETR_HS* divided by the lag of Market Value Assets