Review of Accounting Studies (2019) 24:1114–1145
https://doi.org/10.1007/s11142-019-09494-z

Overconfidence and Corporate Tax Policy

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Published online: 13 June 2019

Abstract
Using a sample of firms experiencing exogenous CEO departures, we investigate whether firms with overconfident CEOs avoid more tax. We find robust evidence of a positive relation between proxies for corporate tax avoidance and CEO overconfidence. Because our empirical tests use a panel of firm-years with exogenous CEO departures and include controls for stationary firm effects as well as observable firm characteristics, we can better isolate the role of an idiosyncratic personality trait (i.e., overconfidence) on corporate tax outcomes, thus adding to the literatures on overconfidence, managerial effects, and tax avoidance.

Keywords Overconfidence · Tax avoidance · Manager effects

JEL classification D80 · M40 · H25

1 Introduction

Managerial overconfidence is the tendency of firms' managers to make relatively higher subjective estimates of their ability, judgment, or prospects (Hirshleifer et al. 2012). Building on this behavioral construct, research has hypothesized and documented that managerial overconfidence is associated with riskier investment decisions (Malmendier and Tate 2008; Hirshleifer et al. 2012), more aggressive financial reporting (Schrand and Zechman 2012; Ahmed and Duellman 2013), and more optimistic forecasting (Hribar and Yang 2016). We hypothesize that corporate tax

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avoidance will also be associated with managerial overconfidence, because tax avoidance depends on a combination of investments in tax avoidance strategies, financial reporting to tax authorities, and forecasting responses from tax authorities. Using a dataset of unforced CEO turnover to identify plausibly exogenous shocks to CEO overconfidence, we assess whether CEO overconfidence is associated with corporate tax avoidance.

CEO overconfidence could relate to tax avoidance directly or indirectly. A direct association could exist because the net expected returns to tax avoidance increase with CEO overconfidence, if overconfident managers estimate higher returns or lower costs to investments in tax avoidance. The returns to tax avoidance consist of reduced accounting tax expense and reduced cash tax outflows. The costs of tax avoidance include explicit tax costs, to the extent that tax positions are overturned, and a variety of other costs, such as tax strategy implementation costs (e.g., promoter and attorney fees), implicit taxes, costs of IRS audits and subsequent litigation (e.g., accounting and legal fees), and reputational penalties.[1] Overconfidence is likely to alter expectations of the amounts of these benefits and costs, their subjective probabilities of occurrence, or both, all of which should result in higher expected net returns to tax avoidance.

While we do not distinguish between direct and indirect effects, an indirect association would occur if overconfident CEOs direct their firms to nontax strategies that happen to reduce tax burdens. That is, overconfident CEOs identify nontax projects with high expected net returns, and the company executes tax avoidance around these projects. While our empirical approach includes numerous control variables that reduce the likelihood of indirect effects, we cannot completely eliminate this potential explanation. Indeed, the economic magnitude of some of our results suggests that our tests could be picking up some indirect effects, despite our numerous controls.

We assess whether there is a positive association between CEO overconfidence and tax avoidance, using a primary sample of 1090 to 1220 firm-year observations from 135 publicly traded U.S. firms, all of which experienced an exogenous CEO departure sometime between 1993 and 2007. This setting allows us to minimize the impact of confounds around turnover events and draw stronger inferences about the impact of personality traits on corporate tax outcomes. Our findings suggest managerial overconfidence is associated with higher levels of tax avoidance.

Our study extends the literature on the role of individual manager characteristics on investment and reporting decisions. We focus on CEOs because they likely have the greatest influence on overall corporate strategy, by setting objectives and incentives for their subordinates, even if the CEO is not a tax expert (Dyreng et al. 2010). Research has attempted to identify managerial characteristics, using CEO turnover (e.g., Bertrand and Schoar 2003; Bamber et al. 2010; Dyreng et al. 2010; Chyz 2013). However, Fee et al. (2013) caution that, in many settings, CEO turnover relates endogenously to an organizational crisis that drives board action to deliberately change its leader as well as firm strategy. Our study uses unforced CEO departures (i.e., changes following health issues, CEO death, and natural retirement) from Fee et al. (2013), thus improving econometric identification and reducing the risk that our inferences are spurious products of organizational crises, rather than the product of an actual association between CEO overconfidence and tax policy. In doing so, we build upon Dyreng

[1] See Rego and Wilson (2012) and Gallemore et al. (2014).

et al. (2010)'s finding that executives affect tax avoidance by demonstrating a specific executive characteristic that affects tax avoidance.

Given that CEOs are relatively under-diversified, with vast amounts of personal wealth and human capital tied to a single firm, holding in-the-money stock options signals a CEO's personal belief that his or her firm will outperform a diversified portfolio (Ahmed and Duellman 2013).[2] Consistent with this notion, our primary measure of overconfidence follows prior studies in deeming a CEO overconfident if he or she fails to exercise in-the-money stock options whose average intrinsic value exceeds 67% of the average exercise price per option (Ahmed and Duellman 2013; Campbell et al. 2011; Hirshleifer et al. 2012; Schrand and Zechman 2012; Hribar and Yang 2016).

Our empirical approach assumes that CEO overconfidence is a manager fixed effect that does not vary over time.[3] In other words, CEOs are assumed to be innately overconfident or not, and this distinction is not changed during our sample. A notable benefit of this approach is that it allows us to target variation in overconfidence driven solely by exogenous CEO turnover. This allows for a within-firm research design that compares tax avoidance in periods in which an overconfident CEO is present to those in which an overconfident CEO is not present. However, a disadvantage of this assumption is that is does not allow for the possibility that CEO overconfidence could be contextual, learned, or time-varying.

For our primary analysis, we regress measures of tax avoidance on CEO overconfidence, control variables, firm fixed effects, and year fixed effects. This allows us to isolate the effect of overconfidence while holding constant the firm and controlling for covariates shown in past literature to be associated with tax avoidance.[4] The coefficient estimate on the variable of interest in these regressions represents the mean within-firm effect on tax avoidance that is driven by plausibly exogenous changes in overconfidence. Our results indicate a statistically and economically significant positive relation between tax avoidance and CEO overconfidence. Using our primary specification, we find that CEO overconfidence is associated with a 10.1 percentage point reduction in the firm's cash effective tax rate, a 3.4 percentage point increase in the estimated probability of tax sheltering, and an increase in residual book-tax differences equivalent to 1.3% of total assets.

We conduct a series of robustness tests to ensure that our results are generalizable across various research design choices. We expand our set of control variables to include additional firm and executive characteristics, including CEO narcissism (Olsen and Stekelberg 2016), and find similar inferences. We alter our sample by excluding various years and observations and again find results

[2] Malmendier and Tate (2005) test the validity of their measure by comparing the returns from unexercised in-the-money stock options to hypothetical option exercises coupled with an investment in the S&P 500 index. They find that investment in the index produces higher returns more often than the unexercised option strategy. Specifically, investing the proceeds from exercised in the money options in the S&P 500 index would beat the strategy of holding exercisable in-the-money options 54.14% of the time.

[3] In sensitivity tests, we relax this assumption and find similar results (see Section 4.2).

[4] The tax avoidance measures in our study are consistent with prior literature and include the cash effective tax rate, estimated tax shelter probability (Wilson 2009; Rego and Wilson 2012), and residual book-tax differences not attributable to accruals management (Desai and Dharmpala 2006).

consistent with our prediction. We employ eight alternative measures of CEO overconfidence used elsewhere, with similar results. We also provide anecdotal evidence suggesting that firms with overconfident CEOs are more likely to partake in tax shelters that are eventually revealed.

Finally, we assess whether the chief financial officer (CFO) drives or moderates the association between CEO overconfidence and tax avoidance. First, we consider the possibility that CEOs largely delegate tax policy to CFOs, by investigating whether our main results are driven by a correlation between CEO and CFO overconfidence. We find only inconsistent evidence that CFO overconfidence matters. Second, we consider the role of the CFO as a potential check or enabler on CEO overconfidence with respect to tax policy. We fail to detect evidence of CFOs checking or enabling CEOs. Third, we consider whether beholden CFOs who were hired by new CEOs magnify the positive association between CEO overconfidence and tax avoidance. The evidence suggests that they do.

We contribute to a body of research that investigates manager effects on corporate choices (Bamber et al. 2010; Dyreng et al. 2010). Specifically, our study is the first that we are aware of to use exogenous CEO changes to explain corporate tax strategy. Our study also contributes to the burgeoning literature on corporate tax avoidance. Studies suggest that individual executives' characteristics help determine firms' tax avoidance (Chyz 2013; Olsen and Stekelberg 2016). We extend this literature by relating overconfidence—a specific, widely studied and accepted psychological trait shown to matter in a variety of settings—to corporate tax avoidance. In concurrent research, Hsieh et al. (2018) use a between-firms research design that does not condition on turnover to identify overconfidence, finding that tax avoidance is most strongly associated with CEO overconfidence in the presence of CFO overconfidence. Our within-firm, exogenous CEO turnover research design allows us to make stronger inferences on this relation, chiefly that CEO overconfidence matters regardless of CFO overconfidence. Our study also contributes to managerial overconfidence research that focuses on nontax corporate decisions, such as acquisitions, cash flow sensitivity, financial reporting, and nontax risk taking.[5]

Despite our careful identification strategy, our study is not without limitations. Also, unlike the predicted effect of CEO overconfidence on nontax outcomes in much of the literature (i.e., Malmendier and Tate 2005, 2008; Schrand and Zechman 2012), a link between overconfidence and tax avoidance need not suggest suboptimal firm outcomes. It could be the case that CEO overconfidence leads to an overestimation of the benefits of tax avoidance, underestimation of the net costs of tax avoidance, or both. It could also be the case that overconfident CEOs are more comfortable managing the unique risks, costs, and technical complexities inherent in tax policy. Because the post-turnover period in our sample is of limited length, we cannot observe the full effects of examinations, settlements, and litigation with tax authorities. Furthermore, it is difficult to observe the implementation or unwinding of specific tax strategies outside of the aforementioned link between CEO overconfidence and revealed tax shelters.

[5] See for example Malmendier and Tate (2005, 2008); Hirshleifer et al. (2012); Schrand and Zechman (2012); Ahmed and Duellman (2013); and Ben-David et al. (2013).

Hence we cannot offer evidence as to whether overconfident CEOs overestimate the net benefits of tax avoidance. Instead, we are limited to showing that executive overconfidence helps explain tax avoidance. Our study's limitations could be explored in future research. Finally, using the Fee et al. (2013) sample of exogenous CEO turnover events means that our sample is limited, because these events are relatively rare, which could reduce the generalizability of our results and the power of our tests.

2 Data, measures, and research design

2.1 Data

We begin with a sample of firms experiencing exogenous CEO turnover from Fee et al. (2013). Using Compustat Research Insight CDs and Factiva searches, Fee et al. (2013) identify 824 firms experiencing CEO turnover events related to health, death, and natural retirements from 1990 to 2007, which they classify as exogenous CEO turnover. Fee et al. (2013) infer natural retirements if turnover happens when the CEO is between 63 and 71 at the start of the year. Because some older managers may in fact be forced to depart, Fee et al. (2013) also require that the firm's most recent level of accounting performance exceed the sample annual median. The authors also exclude from this group any departures that are later discovered to be overtly forced.

The Fee et al. (2013) sample excludes financial firms (SIC codes 6000–6999), utilities (SIC codes 4900–4949), non-US firms, and firms with less than $10 million in book assets. We merge this sample to Compustat's XpressFeed and Execucomp files to obtain financial and compensation data. Additionally, we restrict each sample firm to only one turnover event. While none of the firms in Fee et al. (2013)'s sample experience multiple exogenous turnover events, some do experience both exogenous and endogenous CEO departures. If a firm experiences multiple turnover events, then we delete firm-year observations relating to the endogenous event, ensuring that our sample contains only exogenous departures.[6] Consistent with tax accounting research, we also delete observations prior to the enactment of FAS 109. We also require each firm to have at least one observation before and after CEO turnover, while also eliminating turnover year observations. Finally, we delete observations without sufficient data to compute our overconfidence variable. This yields a final sample of between 1090 and 1220 firm-year observations (depending on the measure of tax avoidance used) from 1993 to 2007 for our full multivariate model (see Table 5).[7] Our final sample represents 135 distinct firms, each of which experiences an exogenous CEO turnover event during our sample period.[8]

[6] For example, if firm A experiences an endogenous turnover event in 1996 and an exogenous turnover event in 2001, then we delete observations for firm A prior to 1997.

[7] To reduce the impact of outliers, we winsorize all continuous variables at the 1st and 99th percentiles.

[8] The limited coverage of Execucomp, relative to Compustat, has a pronounced effect in reducing our sample from the 824 firms identified by Fee et al. (2013) to the 135 firms that are usable for our study.

2.2 Measures

We measure tax avoidance in three ways. The first measure, *CASH ETR*, captures the annual cash taxes paid, relative to pretax book income. Consistent with the work of Chen et al. (2010) and Chyz et al. (2013), *CASH ETR* is cash taxes paid (#TXPD) divided by pretax income (#PI).[9] Following Gupta and Newberry (1997) and Robinson et al. (2010), we constrain *CASH ETR* to lie between 0 and 1, set it to 0 for firms with tax refunds, and set it to 1 for firms with positive cash taxes paid and negative or zero income. *CASH ETR* is a clearer signal of tax avoidance, relative to other effective tax rate specifications, due in part to its ability to capture actual cash tax savings (Dyreng et al. 2010). *CASH ETR* is helpful in our study because it captures tax policy choices targeted at both permanent items and timing differences (i.e., deferring taxable income or accelerating deductions relative to GAAP income).

We employ *TAX SHELTER SCORE* as our second measure of tax avoidance. This measure, introduced by Wilson (2009) and Rego and Wilson (2012), represents the inferred probability that a firm engages in a tax shelter. It is estimated with the following equation: $TAX\ SHELTER\ SCORE = \frac{1}{1+e^{-(\alpha+\beta X)}}$, where $\alpha+\beta X = -4.30 + 6.63*BTD - 1.72*Leverage + 2.26*ROA + 1.62*ForeignIncome + 1.56*R\&D$.[10] Because the *TAX SHELTER SCORE* is an inferred probability, it can capture estimated probabilities of tax sheltering but not direct evidence of it. Consequently, our tests are designed to assess whether overconfident CEOs are more or less likely to be engaging in tax sheltering, but based on this variable alone, we cannot say for certain whether they are.

Our third measure of tax avoidance, *BTD_DD*, captures the gap between financial and taxable incomes that is not attributable to accruals management (Desai and Dharmapala 2006) and is therefore viewed as a signal of the extent to which firms avoid taxes (Chen et al. 2010; Chyz et al. 2013). This variable is the residual, $\varepsilon_{i,t}$, from the following regression of $BTD_{i,t}$ (total book-tax differences scaled by lagged total assets) on $TA_{i,t}$ (total accruals scaled by lagged total assets) and a term, μ_i, capturing the firm's average residual over the sample period as in Desai and Dharmapala (2006).

$$BTD_{i,t} = \beta_1 TA_{i,t} + \mu_i + \varepsilon_{i,t}.$$

Like all tax avoidance proxies in the literature, our measures are likely to pick up the construct of tax avoidance with some noise. However, to the extent that we observe consistent results across multiple measures, it seems less likely that this noise is responsible for our results.

[9] We obtain similar results for *CASH ETR* after subtracting special items (SPI) from pretax book income, dropping firms with negative pretax income, or both. We omit the year after turnover from our *CASH ETR* analysis to avoid commingling cash tax payments across CEO regimes. Turnover years are excluded from all analyses.

[10] In estimating *TAX SHELTER SCORE*, *BTD* is pretax book income (#PI) less estimated taxable income scaled by total assets (#AT), where estimated taxable income is (current federal tax expense, #TXFED, plus current foreign tax expense, #TXFO)/0.35, less the change in tax loss carryforwards, #TLCF. *Leverage* is total debt (#DLTT+#DLC) scaled by total assets (#AT). *ROA* is pretax book income (#PI) scaled by total assets (#AT). *ForeignIncome* is foreign pretax income (#PIFO) scaled by total assets (#AT); and 0 if #PIFO is missing. Finally, *R&D* is research and development expenses (#XRD) scaled by total assets (#AT); and 0 if #XRD is missing.

Our primary measure of overconfidence is an options-based proxy commonly used in the overconfidence literature.[11] In sensitivity tests, we also examine alternative measures of overconfidence and find similar results (see Section 4.3). Following prior literature, we identify overconfidence using aggregated option data from Execucomp to estimate the timing of CEO option exercises. If CEOs fail to exercise in-the-money options fairly quickly after vesting, they increase their exposure to the idiosyncratic risk of their company's stock. Because CEOs are generally underdiversified, with large amounts of their personal wealth and human capital tied to their firm, a willingness to postpone stock option exercise signals a CEO's expectation that his or her firm will outperform a hedged portfolio (Ahmed and Duellman 2013).[12]

Using the entire set of available Execucomp data, for each firm-year, we calculate the average value per unexercised exercisable CEO stock option (Execucomp #OPT_UNEX_EXER_EST_VAL divided by Execucomp #OPT_UNEX_EXER_NUM). We then subtract the average value per unexercised exercisable CEO stock option from the stock price at fiscal year-end (#PRCC_F) to obtain the average exercise price per option. Lastly, we divide the average value per option by the average exercise price per option. Studies deem executives overconfident when this ratio, which represents the average moneyness of options, is greater than 67% (Hall and Murphy 2002; Malmendier and Tate 2005). We set *OVERCONFIDENCE* to 1 as a manager fixed effect for CEOs who exhibit overconfidence (i.e., when CEO average moneyness of options exceeds 0.67) at least once and 0 otherwise.[13] Thus we measure overconfidence in a relative sense, as CEOs we deem overconfident display relatively higher overconfidence than those not deemed overconfident.

2.3 Research design

Our sample gives us a setting with unique benefits. First, our setting examines a relatively exogenous shock because CEO departures due to natural retirements, deaths, and health issues avoid the contamination of organizational crises that accompany most other types of CEO departures. Second, our setting allows us to isolate manager effects by controlling for stationary firm characteristics through firm fixed effects, time trends through year fixed effects, and time-varying firm characteristics through control variables. Together, these benefits allow reasonably strong identification of the relation between managerial overconfidence and corporate tax avoidance.

We examine the relation between overconfidence and tax policy using the following model.

[11] See for example Malmendier and Tate (2005, 2008); Campbell et al. (2011); Hirshleifer et al. (2012); Schrand and Zechman (2012); Ahmed and Duellman (2013); Hribar and Yang (2016).

[12] Research suggests that our overconfidence measure is distinguishable from risk seeking (Malmendier and Tate 2005; Ben-David et al. 2013). Executives' risk seeking would predict overinvestment in high-risk, high-return assets, but it would not predict overinvestment in one's own firm. This is because the better-than-average effect combined with miscalibration would lead overconfident executives to underestimate the risk-return profile of their own firm to a greater extent than external investment opportunities. Hence, if overconfident managers were risk seekers, they would be more likely to overinvest in external assets, rather than in their own firm.

[13] Our results are robust to variations on our overconfidence measure as well as wholly different measures of overconfidence. See Sections 4.2 and 4.3.

$$TAX_{it} = \beta_0 + \beta_1 OVERCONFIDENCE_{ij} + \beta_k x_{it} + \beta_i f_i + \beta_t s_t + \varepsilon_{it}. \quad (1)$$

where *TAX* is one of three tax avoidance proxies (*CASH ETR*, *TAX SHELTER SCORE*, or *BTD_DD*); *OVERCONFIDENCE* is our option-based measure of executive overconfidence, discussed above, for executive *j*; *x* is a vector of *k* control variables, measured annually, consistent with prior literature; *f* is a vector of *i* firm fixed effects; *s* is a vector of *t* year fixed effects; and ε is a disturbance term with mean zero. We cluster standard errors by firm in this unbalanced panel.

We predict that firms with overconfident CEOs engage in greater tax avoidance. In Eq. (1), this would be supported by a negative β_1 coefficient estimate, when the dependent variable is *CASH ETR*, and a positive β_1 coefficient estimate, when the dependent variable is *TAX SHELTER SCORE* or *BTD_DD*. Because our regression specification includes firm fixed effects, our variable of interest is essentially an interaction that captures changes in tax avoidance driven by exogenous changes in CEO overconfidence. In other words, for firms that experience a change in CEO overconfidence after a change in CEO (i.e., firms that replace a non-overconfident CEO with an overconfident one and vice versa), β_1 captures the average of firm-specific differences in tax avoidance, when overconfident CEOs are present, relative to periods when they are not present. Firms that experience turnover but not exogenous changes in CEO overconfidence do not impact our main variable of interest. The inclusion of firm fixed effects, along with the requirement that each firm experience an exogenous CEO departure, provides us with a powerful setting, wherein the firm acts as its own control and the only variation in overconfidence stems from an exogenous event.[14] Because CEO departures due to health, disease, and natural retirement are not likely related to a firm's tax avoidance, the effects we observe will approximate the causal effects of changes in CEO overconfidence on tax avoidance.

Despite the fact that our research design reduces endogeneity concerns, firms are not static across time, even in the absence of organizational crisis. We draw on prior literature to obtain a set of control variables for our multivariate tests. Our set of control variables draws from the work of Chyz et al. (2013) and adds several variables that are specific to our research question. Our set of controls includes operating cash flow scaled by total assets (*CASH FLOW*), capital structure in the form of long-term debt scaled by total assets (*LEVERAGE*), a net operating loss indicator (*NOL*), the one-year change in the amount of net operating losses scaled by total assets (Δ*NOL*), *FOREIGN INCOME* scaled by total assets, property, plant, and equipment scaled by total assets (*PP&E*), *INTANGIBLES* scaled by total assets, equity income in earnings scaled by total assets (*EQUITY INCOME*), the natural log of assets (*SIZE)*, *MARKET-TO-BOOK RATIO*, research and development expenditures scaled by total assets (*R&D*), discretionary accruals scaled by total assets (*DISC_ACC*), the ratio of the CEO's stock option grants to total compensation (*COMP_OPTION*), sensitivity of CEO wealth to stock price (*DELTA*), sensitivity of CEO wealth to stock price volatility (*VEGA*), vesting of CEO compensation (*VESTED*), and CEO *TENURE*. *NOL*, Δ*NOL*, *FOREIGN INCOME*, *INTANGIBLES*, *EQUITY INCOME*, and *R&D* are set to 0 when missing.

[14] As Dyreng et al. (2010) point out, the use of firm fixed effects constrains our tests to only consider variation within the firm. Thus, if a firm always experiences lower tax rates than another firm because it operates in lower-taxed jurisdictions, this effect will be captured in its fixed effect.

The full list of variable definitions is available in the appendix. Some of these control variables have also been shown to vary with CEO overconfidence including *R&D* and *LEVERAGE* (Malmendier et al. 2011; Hirshleifer et al. 2012). If the correlations between these variables and both overconfidence and tax avoidance drive our result, including them as covariates in our regressions should control for these effects.[15]

3 Empirical results

3.1 Descriptive statistics

Table 1 presents details of our sample for which we have the necessary data to complete our primary regression analysis. The first row (*Non-OC to OC*) shows that our sample contains 199 treatment observations from 19 firms that replaced a non-overconfident CEO with an overconfident CEO. We average 7.3 years of pre-turnover observations and nearly six years of post-turnover observations in these firms. The second row (*Non-OC to Non-OC*) indicates the presence of 204 firm observations from 29 firms that replaced a non-overconfident CEO with another non-overconfident CEO. These firms average about five years of both pre- and post-turnover data. The third row (*OC to Non-OC*) comprises the 282 observations from 31 treatment firms in our sample that replaced an overconfident CEO with a non-overconfident CEO. We have, on average, over six years of both pre- and post-turnover data for these firms. Row four (*OC to OC*) describes the 535 observations from 56 firms that replaced an overconfident CEO with another overconfident CEO. Our sample contains approximately five years of pre-turnover data and nearly eight years of post-turnover data for these firms. Across the entire sample, our sample averages nearly six years of pre-turnover data and roughly seven years of post-turnover data.

Table 2 presents descriptive statistics for our final sample. The average firm in our sample pays 34.4% of its pretax income in taxes (i.e., *CASH ETR* = 0.344), consistent with other studies that include loss firms (e.g., Robinson et al. 2010).[16] The mean firm has a 67% likelihood of participating in a tax shelter (i.e., *TAX SHELTER SCORE* = 0.670). The mean of the Desai-Dharmapala book-tax difference measure is nearly zero, because it is constructed as the residual from a regression (mean *BTD_DD* = 0.006). The mean of *OVERCONFIDENCE* equals 0.661, which is similar to the percentage of overconfident CEOs reported by Malmendier and Tate (2005) (51.3%) and Hirshleifer et al. (2012) (61.0%), suggesting the proportion of CEOs identified as overconfident in our sample is reasonable. As suggested in our univariate tests described in more detail below, the number of firm-years without the presence of overconfident CEOs appears to provide reasonable opportunities for us to observe exogenous changes in CEO overconfidence.

The average firm in our sample generates positive operating cash flows (mean *CASH FLOW* = 0.144) and has significant debt (mean *LEVERAGE* = 0.238). About

[15] As evident in correlations reported in Table 4, consistent with prior research, *LEVERAGE* is negatively and significantly correlated with *OVERCONFIDENCE*, and *R&D* is positively and significantly correlated with *OVERCONFIDENCE* (Hirshleifer et al. 2012). However, none of the correlation coefficients is high enough to raise concerns regarding multicollinearity.

[16] Excluding loss firms, the mean *CASH ETR* is approximately 30%.

Table 1 Sample composition by nature of CEO turnover

Nature of Turnover	Firms	Firm years	Mean number of years before turnover	Mean number of years before turnover
Non-OC to OC	19	199	7.281	5.882
Non-OC to Non-OC	29	204	4.722	4.617
OC to Non-OC	31	282	6.493	6.138
OC to OC	56	535	5.048	7.985
Total	135	1220	5.815	6.778

This table presents the number of firms, firm-year observations, and mean numbers of observations before and after turnover for each firm in each of four categories of turnover. *Non-OC to OC* indicates a firm that replaced a non-overconfident outgoing CEO with an overconfident CEO. *Non-OC to Non-OC* indicates a firm that replaced a non-overconfident outgoing CEO with a similarly non-overconfident CEO. *OC to Non-OC* indicates a firm that replaced an overconfident outgoing CEO with a non-overconfident CEO. *OC to OC* indicates a firm that replaced an overconfident outgoing CEO with a similarly overconfident CEO

Table 2 Descriptive statistics

Variable	N	Mean Std	Dev.	P25	P50	P75
CASH ETR	1090	0.344	0.250	0.201	0.288	0.388
TAX SHELTER SCORE	1220	0.670	0.194	0.543	0.693	0.831
BTD_DD	1220	0.006	0.045	−0.010	0.010	0.030
OVERCONFIDENCE	1220	0.661	0.473	0.000	1.000	1.000
CASH FLOW	1220	0.144	0.076	0.096	0.140	0.190
LEVERAGE	1220	0.238	0.130	0.147	0.240	0.332
NOL	1220	0.265	0.441	0.000	0.000	1.000
Δ NOL	1220	0.020	0.081	0.000	0.000	0.002
FOREIGN INCOME	1220	0.023	0.034	0.000	0.009	0.038
PP&E	1220	0.347	0.218	0.171	0.305	0.487
INTANGIBLES	1220	0.150	0.156	0.016	0.104	0.236
EQUITY INCOME	1.220	0.001	0.005	0.000	0.000	0.000
SIZE	1220	7.886	1.393	6.926	7.743	8.908
MARKET-TO-BOOK RATIO	1220	3.563	5.373	1.880	2.699	4.144
R&D	1220	0.021	0.033	0.000	0.008	0.029
DISC ACC	1.220	−0.065	0.645	−0.048	−0.006	0.030
COMP_OPTION	1220	0.097	0.203	0.000	0.000	0.000
DELTA	1220	647.409	1883.620	92.472	211.897	536.398
VEGA	1220	151.126	231.503	32.399	72.428	165.674
VESTED	1220	0.005	0.006	0.001	0.003	0.007
TENURE	1220	4.948	5.833	1.000	3.000	6.000

This table presents the number of observations, mean, standard deviation, 25th percentile, median, and 75th percentile for each of our variables used in the main tests (Table 5). Variable definitions found in the appendix

27% of firms in our sample have NOLs, and yearly NOL changes amount to 2% of assets. The average firm in our sample also generates foreign income worth 2.3% of total assets. Our average sample firm has about 35% of total assets in fixed assets and 15% of its assets in intangibles. Most firms in our sample lack substantial equity income in earnings (mean *EQUITY INCOME* = 0.001). Mean total assets (unlogged) is $2.659 billion, suggesting firms in our sample are economically significant. Average *MARKET-TO-BOOK RATIO* is 3.563, indicating our sample firms have significant growth options. Our average firm spends 2.1% of its total assets in *R&D* and has income-reducing discretionary accruals (*DISC_ACC*) amounting to 6.5% of assets. Stock options comprise 9.7% of the mean CEO's annual compensation package (mean *COMP_OPTION* = 0.097). The mean values of *DELTA* (*VEGA*) indicate that a 1% change in stock price level (volatility) corresponds to a change in CEO wealth of $647,409 ($151,126). Mean CEO *TENURE* is nearly five years.

3.2 Univariate analysis

Table 3 reports changes in tax avoidance for different subgroups of turnover that were summarized in Table 1. We first partition the sample into two panels (Panel A or Panel B), based on *OVERCONFIDENCE* before CEO turnover. All observations in Panel A have non-overconfident CEOs before turnover (i.e., "Non-OC"), while all observations in Panel B have overconfident CEOs before turnover (i.e., "OC"). Importantly, in each panel, there is a group for whom turnover leads to a change in overconfidence and a group where turnover does not lead to such a change. Using this partitioning approach gives us eight subgroups (four in each panel).

Group (1) contains pre-turnover observations with non-overconfident CEOs, conditional on their upcoming switch to an overconfident CEO. Group (2) contains post-turnover observations from Group (1) firms. Group (3) contains pre-turnover observations with non-overconfident CEOs, conditional on their upcoming switch to another non-overconfident CEO. Group (4) contains post-turnover observations from Group (3) firms. Groups 5, 6, 7, and 8 in Panel B parallel Groups 1, 2, 3, and 4 respectively from Panel A, but all groups in Panel B begin with overconfident CEOs in the pre-turnover period.

For each subgroup, we present the number of firms as well as the mean and median tax avoidance statistics. Statistical tests for differences in means and medians before and after turnover reported in Table 3 are assessed using within-firm paired samples. In an untabulated analysis, we also perform statistical tests of differences in means and medians, assuming pooled subgroup samples, and find somewhat stronger results.

We also present tests of the univariate difference-in-differences, listed as "DID mean" and "DID median," which compare the pre- to post-period differences of treatment firms (i.e., *Non-OC to OC* and *OC to Non-OC*) with the pre- to post-period differences of each group's respective no change firms (i.e., *Non-OC to Non-OC* and *OC to OC*, respectively). Overconfidence proxies are somewhat coarse, and therefore levels of overconfidence can change even within no-change subsamples. As a result, we do not make predictions about changes in tax avoidance when overconfidence does not change. Nevertheless, we believe that including these firms can be informative and helpful in our univariate tests, because research has documented increases in tax avoidance over time (Dyreng et al. 2017; Desai and Dharmapala 2009, Plesko 2004;

Table 3 Univariate analysis

Panel A – All start with Non-OC

	Before Turnover (1) *OVERCONFIDENCE* = 0			After Turnover (2) *OVERCONFIDENCE* = 1		diff in mean		diff in median	
	n	mean	median	mean	median	(2)-(1)		(2)-(1)	
CASH ETR	19	0.412	0.383	0.267	0.254	-0.145	***	-0.129	***
TAX SHELTER SCORE	19	0.594	0.602	0.709	0.717	0.115	***	0.115	***
BTD_DD	19	-0.003	0.002	0.023	0.023	0.026	***	0.021	***

	Before Turnover (3) *OVERCONFIDENCE* = 0			After Turnover (4) *OVERCONFIDENCE* = 0		diff in mean	diff in median
	n	mean	median	mean	median	(4)-(3)	(4)-(3)
CASH ETR	29	0.370	0.337	0.433	0.425	0.063	0.088
TAX SHELTER SCORE	29	0.653	0.662	0.668	0.677	0.015	0.015
BTD_DD	29	-0.001	0.004	0.003	0.009	0.004	0.005

	DID mean		DID median	
CASH ETR	-0.208	***	-0.217	***
TAX SHELTER SCORE	0.100	***	0.100	***
BTD_DD	0.022	**	0.016	*

Panel B – All start with OC

	Before Turnover (5) *OVERCONFIDENCE* = 1			After Turnover (6) *OVERCONFIDENCE* = 0		diff in mean		diff in median	
	n	mean	median	mean	median	(6)-(5)		(6)-(5)	
CASH ETR	31	0.365	0.350	0.462	0.479	0.097	*	0.129	
TAX SHELTER SCORE	31	0.584	0.588	0.577	0.576	-0.007		-0.012	
BTD_DD	31	0.001	0.004	-0.010	-0.008	-0.011		-0.012	

	Before Turnover (7) *OVERCONFIDENCE* = 1			After Turnover (8) *OVERCONFIDENCE* = 1		diff in mean		diff in median	
	n	mean	median	mean	median	(8)-(7)		(8)-(7)	
CASH ETR	56	0.378	0.324	0.285	0.270	-0.093	**	-0.054	**
TAX SHELTER SCORE	56	0.646	0.649	0.724	0.727	0.078	***	0.078	***
BTD_DD	56	0.005	0.006	0.014	0.014	0.009		0.008	***

	DID mean		DID median	
CASH ETR	0.190	***	0.183	**
TAX SHELTER SCORE	-0.085	***	-0.090	***
BTD_DD	-0.020	**	-0.020	**

This table presents the results of univariate tax avoidance paired *t*-tests of differences in means and medians from the pre- to post-turnover period for each of the firm categories described in Table 1. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively, for these one-sided tests. DID mean and DID median refer to tests of the difference-in-differences; i.e., comparing the difference for the treatment group with the difference for the respective no-change group below it. Variable definitions found in the appendix.

Yin 2003). Accordingly this provides an approximate baseline change in tax avoidance for firms that experience no change in overconfidence that can help address the effects of any potential time trends on tax avoidance in a univariate setting.[17]

[17] Both time trends in tax avoidance and the somewhat coarse nature of our overconfidence measure could at least partially explain the increase in corporate tax avoidance we document when another overconfident CEO replaces an overconfident CEO.

The tests of differences summarized in Panel A reveal that the pre-period firms in Group (1) undertook more aggressive tax avoidance, following their switch to overconfident CEOs in Group (2). Meanwhile, the group of pre-period firms (Group 3) that did not have a change in CEO overconfidence, despite having CEO turnover, experienced no detectable change in post-period tax avoidance (Group 4). Together, the statistically significant difference-in-differences mean and median tests show sharply greater tax avoidance for firms that hired an overconfident CEO in the post-period versus those that did not.

In Panel B, we observe that the nominal mean and median changes are consistent with firms engaging in less tax avoidance, if they switched to a non-overconfident CEO in the post-period (Group 6 versus Group 5); however, in only one case (mean of *CASH ETR*) is the difference statistically significant. In untabulated pooled sample tests, we find three statistically significant differences. Meanwhile, firms that began with an overconfident CEO who was replaced by another overconfident CEO, following turnover (Group 8 versus Group 7), appear to increase their level of tax avoidance. In only one case is the difference not statistically significant (mean of *BTD_DD*). Together, the statistically significant difference-in-differences in mean and median tests reveal less tax avoidance for firms that hired non-overconfident replacement CEOs, compared to those that hired overconfident replacements, and vice versa. We display the results of these tests graphically for our *CASH ETR* measure in Figs. 1 and 2.

For reasons noted above, we believe that our univariate difference-in-differences tests should be interpreted with caution. We rely on our multivariate analysis to document support for our hypothesis, as this analysis controls for covariates and includes firm fixed effects, ensuring that econometric identification is not based on no-change observations.

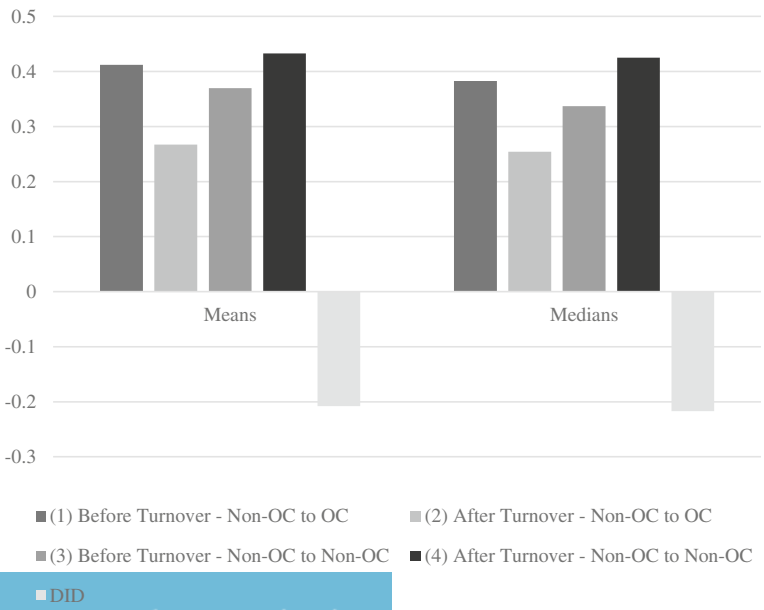

Fig. 1 Changes in *CASH ETR* for firms starting without an overconfident CEO (Panel A of Table 3)

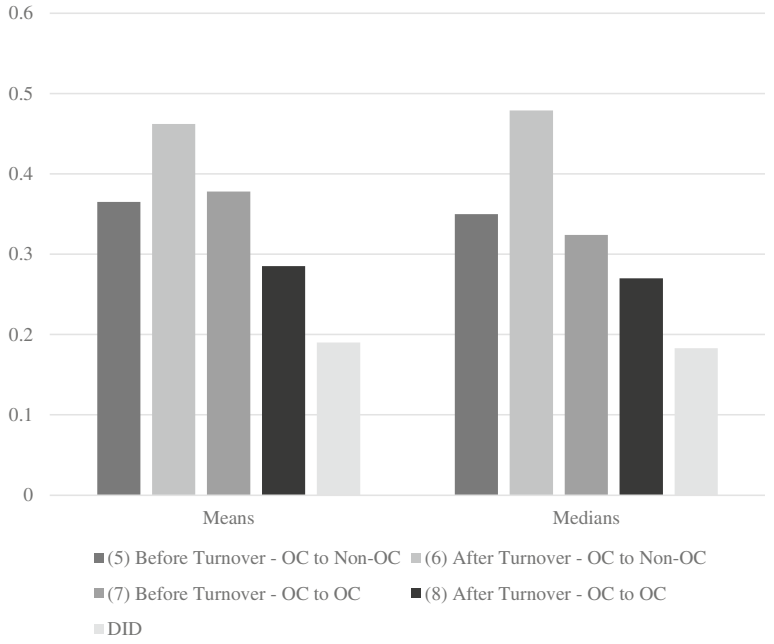

Fig. 2 Changes in *CASH ETR* for firms starting with an overconfident CEO (Panel B of Table 3). Figures 1 and 2 are graphical representations of the Table 3 univariate difference-in-difference analyses. The graphs display the eight groups listed in Table 3 and the difference-in-difference. Fig. 1 presents the means and medians for *CASH ETR* before and after changes in CEO turnover for each of the groups (1) through (4) that had non-overconfident CEOs present before turnover (i.e., *OVERCONFIDENCE* = 0). Panel B does the same for groups (5) through (8) that had overconfident CEOs present prior to turnover (i.e., *OVERCONFIDENCE* = 1). Each graph also presents the difference-in-difference (DID) calculated as the difference between the changes in *CASH ETR* for the group that experiences a change in CEO overconfidence, relative to the group that does not. *CASH ETR* is cash paid for taxes divided by pre-tax income. *CASH ETR* is constrained to lie between 0 and 1 and is set to 0 for firms with tax refunds and to 1 for firms with positive taxes paid and negative or zero income. *OVERCONFIDENCE* is a time-invariant measure of overconfidence, based on the ratio of CEO options in the money. The measure is binary and takes a value of 1 for CEOs identified as overconfident and 0 otherwise

3.3 Correlations

Table 4 presents correlation coefficients for the main variables used in our study and for variables used in robustness testing (Pearson above, Spearman below). Correlation coefficients in bold are statistically significant at the 0.10 level. As expected *CASH ETR* relates negatively to *TAX SHELTER SCORE* and *BTD_DD*. Also as expected, *TAX SHELTER SCORE* and *BTD_DD* are positively correlated with each other. Each of the correlations between *OVERCONFIDENCE* and our proxies for tax avoidance support our expectation. *OVERCONFIDENCE* is associated with lower *CASH ETR* (Spearman correlation = −0.19, p value <0.10), higher *TAX SHELTER SCORE* (Spearman correlation = 0.10, p value <0.10), and higher *BTD_DD* (Spearman correlation = 0.13, p value <0.10). Overall, the patterns shown in the simple correlations suggest that CEO overconfidence is positively associated with tax avoidance, consistent with our prediction.

Table 4 Correlations

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(1)	CASH ETR		**−0.38**	**−0.65**	**−0.22**	**−0.20**	**0.06**	0.00	**0.07**	**−0.15**	−0.10	0.03	**−0.07**	**−0.08**	**−0.09**	**0.05**	**0.06**
(2)	TAX SHELTER SCORE	**−0.26**		**0.51**	**0.11**	**0.32**	**−0.12**	0.01	**−0.09**	**0.36**	0.03	**0.10**	**0.20**	**0.82**	**0.14**	**−0.09**	−0.03
(3)	BOOK-TAX DIFFERENCES_DD	**−0.63**	**0.42**		**0.15**	**0.23**	−0.01	0.00	**−0.09**	**0.19**	**0.08**	0.00	**0.06**	**0.11**	**0.09**	**−0.05**	**0.10**
(4)	OVERCONFIDENCE	**−0.19**	**0.10**	**0.13**		**0.13**	**−0.13**	0.02	0.01	**0.05**	**−0.05**	0.01	**0.05**	0.00	**0.07**	**0.11**	−0.03
(5)	CASH FLOW	−0.02	**0.28**	**0.18**	**0.13**		**−0.32**	**−0.17**	**−0.14**	**0.28**	**0.12**	**−0.14**	**0.14**	**0.08**	**0.25**	**0.06**	**−0.09**
(6)	LEVERAGE	−0.02	**−0.11**	0.00	**−0.14**	**−0.34**		**0.14**	**−0.08**	**−0.17**	**0.16**	**0.18**	−0.02	**0.17**	−0.03	**−0.24**	0.01
(7)	NOL	**−0.11**	**0.03**	0.03	0.02	**−0.18**	**0.13**		**0.41**	**0.10**	**−0.16**	**0.11**	0.03	**0.06**	0.00	**0.09**	−0.01
(8)	DNOL	**−0.11**	0.01	0.03	0.02	**−0.19**	**0.11**	**0.98**		**0.13**	**−0.18**	**0.08**	−0.03	**−0.06**	−0.01	**0.46**	**0.09**
(9)	FOREIGN INCOME	**−0.14**	**0.34**	**0.13**	0.04	**0.14**	**−0.09**	**0.14**	**0.15**		**−0.15**	0.00	**0.26**	**0.26**	**0.15**	**0.19**	**−0.04**
(10)	PP&E	−0.03	0.02	**0.08**	**−0.07**	**0.17**	**0.16**	**−0.15**	**−0.17**	**−0.15**		**−0.51**	**0.11**	**0.08**	**−0.11**	**−0.32**	−0.01
(11)	INTANGIBLES	0.02	**0.05**	−0.02	0.04	**−0.13**	**0.15**	**0.14**	**0.14**	**0.12**	**−0.53**		−0.04	**0.16**	0.00	−0.03	−0.01
(12)	EQUITY INCOME	**−0.05**	**0.17**	0.04	0.04	**0.05**	**0.06**	**0.06**	0.04	**0.20**	**0.11**	0.03		**0.24**	0.04	**−0.08**	**−0.08**
(13)	SIZE	**−0.07**	**0.86**	**0.12**	−0.01	0.04	**0.20**	**0.09**	**0.06**	**0.24**	**0.07**	**0.11**	**0.19**		**0.06**	**−0.18**	0.00
(14)	MARKET-TO-BOOK RATIO	**−0.09**	**0.36**	**0.20**	**0.28**	**0.53**	**−0.16**	−0.02	−0.03	**0.25**	**−0.16**	0.02	**0.07**	**0.18**		**0.07**	0.00
(15)	R&D	**−0.06**	0.02	0.03	**0.12**	0.04	**−0.16**	**0.06**	**0.07**	**0.33**	**−0.27**	**0.05**	−0.02	**−0.09**	**0.17**		0.02
(16)	DISC_ACC	−0.03	0.00	**0.13**	−0.04	**−0.29**	**0.10**	**−0.04**	**−0.05**	**−0.06**	**0.20**	**−0.12**	0.01	0.00	**−0.15**	**−0.11**	
(17)	COMP_OPTION	−0.09	**−0.16**	0.01	−0.04	**−0.02**	**−0.04**	**0.11**	**0.11**	**0.06**	**−0.07**	**0.09**	0.03	**−0.20**	0.00	**0.11**	0.01
(18)	DELTA	**−0.12**	**0.49**	**0.19**	**0.24**	**0.26**	**−0.10**	**0.06**	0.04	**0.14**	**−0.11**	**0.07**	0.03	**0.42**	**0.42**	0.02	**−0.05**
(19)	VEGA	**−0.12**	**0.60**	**0.15**	**0.06**	**0.15**	**0.05**	**0.09**	**0.08**	**0.24**	**−0.13**	**0.26**	**0.09**	**0.59**	**0.28**	−0.02	−0.03
(20)	VESTED	**−0.06**	**−0.39**	−0.03	**0.16**	**−0.16**	0.04	**0.05**	**0.05**	**−0.09**	**−0.14**	**0.13**	**−0.09**	**−0.42**	**−0.18**	**0.05**	0.01
(21)	TENURE	**−0.07**	**0.09**	**0.07**	**0.22**	0.01	0.00	−0.01	−0.02	−0.04	**0.05**	−0.03	−0.02	**0.06**	**0.06**	**−0.08**	0.01
(22)	ABILITY	**−0.06**	0.01	**0.07**	**0.13**	**0.18**	−0.02	−0.03	−0.04	0.01	**−0.15**	**0.07**	−0.03	**−0.06**	**0.18**	−0.01	**−0.10**

Table 4 (continued)

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(23)	NARCISSIM	**−0.08**	**0.15**	**0.07**	0.03	0.04	**0.10**	0.01	0.01	**0.14**	**0.08**	**−0.08**	**0.08**	**0.17**	−0.01	0.02	0.00
(24)	MISSING_NARCISSIM	**0.11**	**−0.27**	**−0.09**	**−0.18**	**−0.17**	**0.05**	**0.10**	**0.11**	**−0.08**	−0.01	0.02	**−0.07**	**−0.24**	**−0.10**	0.01	−0.02
(25)	STOCK_OWN	0.02	**−0.42**	−0.03	**0.09**	**−0.07**	0.01	0.00	−0.01	**−0.23**	**−0.08**	0.02	**−0.10**	**−0.47**	**−0.08**	**−0.14**	0.00
(26)	HELD_PCT	**−0.06**	**−0.05**	0.04	0.01	0.04	−0.02	**0.08**	**0.09**	**0.11**	**−0.16**	**0.15**	0.02	**−0.11**	**0.05**	**0.10**	−0.04
(27)	INVEST	**−0.07**	0.03	**0.13**	**0.05**	**0.27**	0.00	**−0.15**	**−0.16**	**−0.07**	**0.76**	**−0.52**	**0.07**	0.01	0.00	**−0.13**	**0.11**
(28)	LITSCORE	0.01	**0.39**	−0.02	**−0.06**	**−0.09**	**0.17**	**0.10**	**0.10**	0.04	0.05	−0.03	0.02	**0.53**	**−0.08**	**−0.05**	−0.01
(29)	CSCORE	0.03	**0.47**	0.04	0.00	**0.06**	**−0.09**	−0.05	**−0.06**	**0.08**	**0.17**	−0.05	0.03	**0.50**	−0.03	**−0.08**	0.02
(30)	ANNRET	**−0.11**	**0.08**	**0.08**	**0.22**	**0.14**	**−0.10**	0.00	−0.01	**0.09**	−0.01	−0.04	0.01	0.02	**0.32**	0.01	−0.02
(31)	P_TAX_AGG	**−0.05**	−0.04	0.03	0.02	−0.02	**0.07**	0.04	**0.06**	0.05	**−0.07**	−0.04	−0.04	−0.05	**0.08**	**0.12**	0.04
(32)	EXER_HOLD	**−0.08**	**−0.05**	**0.08**	**0.09**	−0.03	**0.09**	0.02	0.02	0.04	−0.02	0.05	**−0.06**	**−0.06**	0.02	**0.16**	**0.06**

	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)
(1)	−0.01	**−0.06**	**−0.10**	0.03	**−0.05**	**−0.11**	**−0.08**	**0.17**	0.01	−0.03	**−0.11**	**0.08**	−0.03-	**0.12**	−0.01	**−0.05**
(2)	**−0.14**	**0.21**	**0.44**	**−0.35**	0.04	0.01	**0.16**	**−0.30**	**−0.14**	−0.03	0.00	**0.27**	**0.44**	0.04	−0.04	−0.04
(3)	**−0.02**	**0.09**	**0.13**	**−0.05**	0.02	**0.08**	**0.06**	**−0.12**	−0.03	0.05	**0.10**	**−0.07**	**0.05**	**0.09**	0.04	**0.07**
(4)	−0.01	**0.09**	−0.01	**0.15**	**0.17**	**0.14**	0.03	**−0.18**	0.05	0.01	0.05	**−0.06**	0.02	**0.21**	0.02	**0.09**
(5)	0.01	**0.18**	**0.19**	**−0.14**	**0.06**	**0.16**	**0.04**	**−0.16**	−0.02	**0.05**	**0.21**	**−0.11**	**0.06**	**0.11**	−0.03	−0.02
(6)	**−0.04**	−0.02	0.02	0.03	−0.04	−0.01	**0.09**	0.05	**0.05**	−0.01	0.00	**0.13**	**−0.11**	**−0.07**	**0.06**	**0.08**
(7)	**0.11**	**0.08**	0.02	0.04	**−0.06**	0.01	0.01	**0.10**	**0.09**	**0.07**	**−0.16**	**0.11**	**−0.04**	−0.01	0.04	0.02
(8)	**0.16**	−0.02	0.00	**0.06**	**−0.07**	0.05	−0.03	**0.15**	−0.03	**0.10**	**−0.15**	**0.07**	−0.03	0.01	0.04	−0.02
(9)	0.04	**0.28**	**0.19**	**−0.08**	−0.03	0.03	**0.12**	−0.08	**−0.08**	**0.04**	**−0.10**	0.03	**0.08**	**0.09**	0.03	−0.01
(10)	**−0.08**	−0.02	−0.02	**−0.10**	**0.08**	**−0.18**	**0.06**	−0.01	−0.04	**−0.15**	**0.70**	0.01	**0.16**	−0.01	**−0.07**	−0.03
(11)	**0.07**	0.03	**0.18**	**0.05**	**−0.11**	**0.04**	**−0.08**	−0.02	**0.06**	**0.12**	**−0.45**	−0.02	0.03	**−0.05**	−0.02	0.01

Table 4 (continued)

	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)
(12)	0.02	**0.15**	**0.26**	**−0.07**	0.01	**−0.10**	**0.08**	**−0.08**	−0.03	0.00	0.06	0.02	**0.07**	0.00	−0.04	**−0.07**
(13)	**−0.18**	**0.20**	**0.50**	**−0.37**	0.01	**−0.13**	**0.14**	**−0.25**	**−0.14**	**−0.12**	−0.03	**0.44**	**0.49**	−0.03	**−0.05**	**−0.07**
(14)	**0.05**	**0.18**	**0.14**	−0.02	0.04	**0.14**	−0.01	−0.02	0.00	**0.07**	**−0.06**	−0.05	**−0.29**	**0.12**	0.02	−0.01
(15)	**0.20**	−0.04	−0.03	**0.08**	**−0.08**	**0.10**	**−0.06**	**0.12**	−0.03	**0.09**	**−0.15**	0.03	**−0.10**	0.03	**0.15**	**0.15**
(16)	**−0.10**	−0.01	−0.03	0.00	0.03	−0.02	−0.04	**0.07**	−0.04	**−0.05**	0.04	**0.05**	0.00	0.00	0.02	0.01
(17)		0.02	0.02	0.01	**−0.17**	**0.06**	**0.09**	−0.01	**0.08**	**0.19**	**−0.06**	−0.03	**−0.18**	0.04	**0.13**	0.01
(18)	**−0.15**		**0.27**	−0.01	**0.14**	0.02	0.04	**−0.13**	**0.25**	0.01	−0.01	0.03	**−0.09**	**0.06**	−0.02	−0.02
(19)	0.00	**0.56**		0.00	0.01	**−0.04**	0.03	**−0.17**	**−0.06**	**0.07**	**−0.07**	**0.17**	**0.16**	−0.03	−0.01	0.00
(20)	**0.08**	0.02	**0.08**		**0.13**	**0.08**	0.00	0.00	**0.11**	**0.13**	**−0.07**	**−0.19**	**−0.24**	0.04	**0.09**	**0.16**
(21)	**−0.21**	**0.23**	**0.12**	**0.21**		**0.05**	−0.01	−0.01	**0.27**	**−0.15**	**0.11**	**−0.08**	**0.08**	**0.07**	−0.05	−0.02
(22)	**−0.02**	**0.09**	0.04	**0.08**	**0.05**		0.03	0.00	0.04	**0.09**	0.00	**−0.08**	**−0.14**	0.03	−0.01	0.03
(23)	**0.11**	0.03	**0.14**	0.02	0.00	0.03		**−0.40**	0.00	**0.09**	0.03	0.03	**0.09**	0.04	0.01	0.00
(24)	−0.03	**−0.27**	**−0.23**	−0.02	−0.04	−0.02	**−0.40**		0.04	**−0.14**	0.00	**0.07**	**−0.19**	**−0.11**	**−0.08**	**−0.09**
(25)	−0.03	0.04	**−0.28**	**0.37**	**0.38**	**0.07**	−0.05	0.03		−0.01	−0.03	**−0.09**	**−0.08**	0.02	−0.03	−0.03
(26)	**0.22**	0.02	**0.15**	**0.18**	**−0.08**	**0.11**	**0.10**	**−0.13**	0.03		**−0.13**	**−0.13**	**−0.25**	0.00	**0.12**	**0.21**
(27)	**−0.09**	−0.04	**−0.17**	**−0.16**	**0.08**	−0.02	**0.06**	−0.04	**−0.06**	**−0.16**		**0.08**	**0.08**	−0.02	**−0.05**	0.01
(28)	**−0.07**	**0.17**	**0.33**	**−0.28**	−0.04	**−0.05**	0.05	0.03	**−0.30**	**−0.09**	**0.08**		**0.08**	**−0.21**	0.03	0.01
(29)	**−0.22**	**0.20**	**0.17**	**−0.30**	**0.10**	**−0.11**	**0.10**	**−0.18**	**−0.27**	**−0.27**	**0.12**	**0.14**		0.01	−0.04	−0.09
(30)	0.02	**0.20**	−0.03	−0.01	**0.05**	0.03	**0.06**	**−0.13**	0.03	−0.02	−0.02	**−0.25**	0.06		0.02	0.04
(31)	**0.14**	0.03	0.03	**0.06**	−0.03	−0.01	0.01	**−0.08**	−0.05	**0.14**	**−0.05**	0.03	−0.04	0.01		**0.37**
(32)	0.03	**0.06**	**0.06**	**0.10**	0.03	0.04	0.00	**−0.09**	**0.07**	**0.21**	0.03	0.01	**−0.12**	0.01	**0.37**	

This table presents the correlation coefficients among the variables used in our main analysis and robustness testing. Pearson correlations appear above the diagonal, and Spearman correlations appear below. Coefficients in **bold** indicate statistical significance at the 10% level. Variable definitions found in the appendix

Table 5 CEO Overconfidence and corporate tax policy

	CASH ETR		*TAX SHELTER SCORE*		*BTD_DD*	
H1: β_1	(−)		(+)		(+)	
Parameter	Coeff	Std Err	Coeff	Std Err	Coeff	Std Err
OVERCONFIDENCE	−0.101	0.042***	0.034	0.016**	0.013	0.006**
CASH FLOW	−0.507	0.232**	0.335	0.107***	0.054	0.053
LEVERAGE	−0.109	0.136	−0.328	0.067***	0.009	0.033
NOL	0.003	0.037	0.002	0.015	−0.002	0.006
ΔNOL	0.016	0.334	−0.022	0.219	−0.024	0.064
FOREIGN INCOME	−2.043	0.729***	0.715	0.380*	0.403	0.158**
PP&E	0.029	0.204	0.032	0.076	0.044	0.041
INTANGIBLES	−0.135	0.177	0.045	0.058	0.031	0.026
EQUITY INCOME	−2.974	2.343	−0.965	1.817	−0.238	0.747
SIZE	−0.036	0.046	0.127	0.017***	0.003	0.009
MARKET-TO-BOOK RATIO	−0.001	0.001	0.000	0.000**	0.000	0.000*
R&D	0.140	1.060	−0.698	0.783	−0.506	0.266*
DISC_ACC	0.001	0.011	0.003	0.003		
COMP_OPTION	0.008	0.067	0.003	0.023	−0.004	0.012
DELTA	0.000	0.000**	0.000	0.000	0.000	0.000
VEGA	0.000	0.000**	0.000	0.000*	0.000	0.000***
VESTED	0.634	2.611	−0.338	0.883	−0.031	0.650
TENURE	−0.002	0.002	0.000	0.001	0.000	0.000
Firm fixed effects	Yes		Yes		Yes	
Year fixed effects	Yes		Yes		Yes	
N	1090		1220		1220	
R-squared	0.365		0.874		0.365	

This table presents the results of OLS regression analysis of tax avoidance on CEO overconfidence and control variables. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels respectively for one-sided tests examining our empirical prediction and for two-sided tests for the remaining variables. Standard errors are clustered by firm. Variable definitions found in the appendix

3.4 Multivariate results

Table 5 reports multivariate regression results of model (1) testing our prediction. All regressions include both firm and year fixed effects and are performed on a set of exogenous CEO departures from Fee et al. (2013). As a result, our variable of interest captures the average of firm-specific differences in tax avoidance when overconfident CEOs are present, relative to periods when they are not. Consistent with our univariate results, we document a negative and statistically significant relation between *OVERCONFIDENCE* and *CASH ETR* (coefficient = −0.101, p value <0.01). We also document positive and statistically significant relations between *OVERCONFIDENCE* and *TAX SHELTER SCORE* (coefficient = 0.034, p value <0.05) and *BTD_DD* (coefficient = 0.013, p value <0.05). Our results appear to be economically meaningful. We

find that CEO overconfidence is associated with a decrease in cash effective tax rates of 10.1 percentage points, a 3.4 percentage point increase in the likelihood of engaging in a tax shelter, and a 1.3 percentage point increase in Desai and Dharmapala (2006) book-tax differences.

Overall, our multivariate results support our prediction, suggesting that overconfident CEOs influence corporate policy toward greater tax avoidance.[18] Our results also appear to be reasonable, relative to recent literature that seeks to document executive specific determinants of tax avoidance. For example, Dyreng et al. (2010) find that executives at the 25th percentile of fixed effects, based on effect magnitude, led to a reduction in their firms' *CASH ETR* of 8 percentage points. However, the relatively large size of the coefficient estimate on *CASH ETR* in our study suggests that indirect pathways (i.e., overconfident CEOs direct their firms to nontax strategies that happen to reduce tax burdens) could be partially explaining our result.

4 Additional analyses

4.1 Controlling for CEO personal traits, ability, and narcissism

While our setting allows for strong econometric identification, we further address correlated omitted variable concerns by including additional control variables in Eq. 1. We include these additional covariates in a separate model, as these characteristics might overcontrol for our effect of interest. We add controls for governance (CEO ownership, *STOCK_OWN*; institutional ownership, *HELD_PCT*); CEO ability, *ABILITY* (Koester et al. 2016); CEO narcissism, *NARCISSISM* (Olsen and Stekelberg 2016) combined with an indicator variable, *MISSING_NARCISSISM* to preserve observations when *NARCISSISM* is missing; capital expenditures, *INVEST*; accounting conservatism, *CSCORE*; litigation risk, *LITSCORE* (Kim and Skinner 2012); CEOs' personal tax aggressiveness, *P_TAX_AGG* (Chyz 2013); firm-specific stock performance, *ANNRET*; and an indicator for the presence of executives employing an exercise-and-hold strategy, *EXER_HOLD* (Aboody et al. 2008).[19] We present the results of these regressions in Table 6. We continue to document a positive and statistically significant relation between overconfidence and tax avoidance across all three specifications, although the economic and statistical significance of our coefficient estimates on *OVERCONFIDENCE* are reduced, relative to our main results. These reductions could be attributable to some overlap between our added controls and our variable of interest or with the additional control variables accounting for certain indirect ways by which managerial overconfidence affects tax avoidance. For example, the coefficient estimate

[18] In an untabulated analysis, we examine the association between CEO overconfidence and the three-year standard deviation of cash ETR (Guenther et al. 2017). The results from these tests suggest that overconfident CEOs do not suffer from more volatile cash payments. We interpret these results with caution, because many of the turnovers in our sample do not have a long enough period afterward to draw meaningful conclusions, regarding whether tax avoidance initiated by an overconfident CEO will result in more volatile cash ETRs in the long run.

[19] In an untabulated analysis, we find a low (i.e. -0.06) correlation coefficient between raw CEO narcissism (*NarcScore* per Olsen and Stekelberg 2016) and CEO overconfidence. Since we lack narcissism data for over 25% of the sample, we code missing observations to 0 and include the *MISSING_NARCISSISM* variable to pick up the average effect of narcissism when it is missing.

Table 6 Additional control variables

	CASH ETR		*TAX SHELTER SCORE*		*BTD_DD*	
H1: β_1	(−)		(+)		(+)	
Parameter	Coeff	Std Err	Coeff	Std Err	Coeff	Std Err
OVERCONFIDENCE	−0.070	0.037**	0.024	0.012**	0.008	0.005*
CASH FLOW	−0.433	0.241*	0.340	0.112***	0.055	0.052
LEVERAGE	−0.216	0.134	−0.276	0.077***	0.036	0.033
NOL	0.017	0.033	−0.010	0.012	−0.005	0.005
ΔNOL	−0.150	0.300	0.120	0.170	0.009	0.057
FOREIGN INCOME	−1.563	0.749**	0.545	0.332	0.320	0.138**
PP&E	−0.093	0.220	0.053	0.079	0.061	0.036*
INTANGIBLES	−0.102	0.182	0.042	0.052	0.033	0.025
EQUITY INCOME	−1.988	2.385	−2.211	1.821	−0.849	0.700
SIZE	−0.034	0.043	0.126	0.018***	0.000	0.009
MARKET-TO-BOOK RATIO	−0.003	0.002*	0.000	0.000	0.000	0.000
R&D	−0.037	1.011	−0.938	0.724	−0.601	0.249**
DISC_ACC	0.006	0.008	−0.001	0.003		
COMP_OPTION	0.037	0.067	−0.008	0.021	−0.006	0.011
DELTA	0.000	0.000	0.000	0.000	0.000	0.000
VEGA	0.000	0.000**	0.000	0.000	0.000	0.000***
VESTED	0.046	2.238	−0.767	0.739	−0.157	0.571
TENURE	−0.001	0.002	0.000	0.001	0.000	0.000
ABILITY	−0.134	0.138	0.138	0.048***	0.062	0.023***
NARCISSIM	−0.002	0.026	−0.005	0.008	−0.001	0.004
MISSING_NARCISSIM	0.012	0.054	−0.012	0.021	−0.004	0.011
STOCK_OWN	−0.188	0.655	0.045	0.153	−0.015	0.068
HELD_PCT	−0.014	0.052	0.027	0.017	0.006	0.008
INVEST	−0.597	0.429	0.376	0.119***	0.185	0.070***
LITSCORE	0.025	0.022	−0.015	0.007**	−0.009	0.004**
CSCORE	−1.124	0.471**	0.203	0.168	0.197	0.097**
ANNRET	−0.047	0.020**	−0.002	0.009	0.000	0.004
P_TAX_AGG	−0.066	0.036*	0.027	0.024	0.015	0.012
EXER_HOLD	−0.009	0.028	0.012	0.012	0.005	0.006
Firm fixed effects	Yes		Yes		Yes	
Year fixed effects	Yes		Yes		Yes	
N	1090		1220		1220	
R-squared	0.365		0.874		0.365	

This table presents the results of OLS regression analysis of tax avoidance on CEO overconfidence with additional control variables. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels respectively for one-sided tests examining our empirical prediction and for two-sided tests for the remaining variables. Standard errors are clustered by firm. Variable definitions are found in the appendix

Table 7 Alternative overconfidence proxies and sample restrictions

	CASH ETR				*TAX SHELTER SCORE*				*BTD_DD*			
H1: β1	(−)				(+)				(+)			
OVERCONFIDENCE	n	Coeff	Std Err	R-sq	n	Coeff	Std Err	R-sq	n	Coeff	Std Err	R-sq
Panel A: Alternative measures of overconfidence												
Baseline (Table 5)	1090	−0.101	0.042***	0.365	1220	0.034	0.016**	0.874	1220	0.013	0.006**	0.365
Alternative measures of overconfidence:												
Net Purchase	1090	−0.077	0.047*	0.360	1220	0.025	0.018*	0.873	1220	0.012	0.007**	0.363
OC_FIRM5	1090	−0.040	0.031*	0.358	1220	0.012	0.009*	0.872	1220	0.009	0.004**	0.363
Over-Invest_1	1090	−0.109	0.061**	0.364	1220	0.035	0.020**	0.874	1220	0.012	0.009*	0.363
Over-Invest_2	1090	−0.058	0.041*	0.359	1220	0.016	0.011*	0.873	1220	0.005	0.006	0.360
Factor_5	1090	−0.051	0.016***	0.365	1220	0.015	0.005***	0.874	1220	0.007	0.003***	0.366
Overconfidence_2	1090	−0.076	0.036**	0.363	1220	0.036	0.014***	0.875	1120	0.014	0.005***	0.367
Press	767	−0.056	0.043*	0.449	770	0.023	0.014*	0.906	770	0.013	0.007**	0.449
Miss	846	−0.115	0.089*	0.431	964	0.030	0.021*	0.900	964	0.017	0.011*	0.434
Control variables	Yes				Yes				Yes			
Firm fixed effects	Yes				Yes				Yes			
Year fixed effects	Yes				Yes				Yes			
Panel B: Alternative sample restrictions												
Baseline (Table 5)	1090	−0.101	0.042***	0.365	1220	0.034	0.0340.016**	0.874	0.8741220	0.013	0.006**	0.365
Deleting recession period (i.e., 2001)	1018	−0.104	0.043***	0.370	1130	0.038	0.017**	0.876	1130	0.015	0.006***	0.374
Deleting financial crisis period (i.e., 2007)	1044	−0.117	0.049***	0.356	1160	0.034	0.018**	0.877	1160	0.013	0.007**	0.366

Table 7 (continued)

	CASH ETR				*TAX SHELTER SCORE*				*BTD_DD*			
H1: β1	(−)				(+)				(+)			
OVERCONFIDENCE	n	Coeff	Std Err	R-sq	n	Coeff	Std Err	R-sq	n	Coeff	Std Err	R-sq
Deleting CEOs with less than 5 years of options data	1012	−0.080	0.047**	0.350	1140	0.028	0.017**	0.877	1140	0.010	0.007*	0.361
Deleting observations in the first year of CEO tenure	1032	−0.089	0.040**	0.374	1103	0.033	0.013***	0.886	1103	0.014	0.006***	0.379
Deleting firms with only 1 year of data before or after turnover	1025	−0.096	0.044**	0.343	1136	0.034	0.017**	0.876	1136	0.012	0.006**	0.347
At least 3 or more years per firm before and after turnover	863	−0.075	0.040**	0.310	795	0.037	0.022**	0.881	795	0.013	0.008*	0.325
Control variables	Yes				Yes				Yes			
Firm fixed effects	Yes				Yes				Yes			
Year fixed effects	Yes				Yes				Yes			

This table presents the results of OLS regression analysis of tax avoidance on CEO overconfidence and control variables, where the definition of CEO overconfidence varies among several alternative measures. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively, for one-sided tests examining our empirical prediction and for two-sided tests for the remaining variables. Standard errors are clustered by firm. Variable definitions found in the appendix

This table presents the results of OLS regression analysis of tax avoidance on CEO overconfidence and control variables, after making the various adjustments noted in the table. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively, for one-sided tests examining our empirical prediction and for two-sided tests for the remaining variables. Standard errors are clustered by firm. Variable definitions found in the appendix

on *INVEST* is statistically significant and positive in the *TAX SHELTER SCORE* and *BTD_DD* specifications. If overconfident CEOs make greater capital expenditures (Malmendier and Tate 2005), they could indirectly affect tax avoidance through depreciation deductions.

4.2 Changes to main overconfidence variable

We construct our primary measure of overconfidence purposefully, taking advantage of our unique identification strategy that relies on exogenous CEO departures to create manager fixed effects. This strategy focuses on between-manager differences in overconfidence, rather than within-manager changes over time, assuming that overconfidence is a time-invariant personal trait. Rather than suggesting that certain individuals exhibit constant overconfidence, our view is that certain individuals are more likely to exhibit overconfidence than other individuals. We believe this between-manager strategy offers more impactful changes in CEO overconfidence than a within-manager design, and it also suits our exogenous turnover data.[20] However, some prior studies have defined CEO overconfidence slightly differently; specifically, they have waited to code an individual CEO overconfident until *after* the first instance that CEO's option behavior deems him or her overconfident. Our primary measure back-fills within CEO to code the individual overconfident throughout his or her career. Our alternate variable, *Overconfidence_2*, contains a slight adjustment to our primary measure to strictly follow these prior studies, allowing both within-manager and between-manager differences in overconfidence. Thus *Overconfidence_2* allows the possibility that overconfidence is a dynamic trait, subject to recent experiences. The disadvantage of *Overconfidence_2* is that it cannot fully exploit the exogenous CEO departure data to create a sample of only exogenous changes in CEO overconfidence. The results, reported in Table 7, Panel A, indicate this choice does not alter our inferences.

In an additional untabulated analysis, we further explore alternate versions of our primary overconfidence measure. In our second alternate version, we use a more restrictive moneyness ratio of 100%. For the third alternate version, we require at least two instances of overconfidence to code *OVERCONFIDENCE* to equal 1 across a CEO's entire career. For the fourth alternate version, we wait until we observe a second instance of overconfidence before allowing *OVERCONFIDENCE* to equal 1. Results based on these alternative specifications for overconfidence (untabulated) are very similar to the primary results reported in Table 5.

[20] For example, consider executive Z who works for two different firms, FIRM1 and FIRM2. We code *OVERCONFIDENCE* as 1 for firms employing executive Z if she demonstrates overconfidence at any point in the sample. The key reason for this is that it allows *OVERCONFIDENCE* to only vary with executive Z coming in or out of the firm. If we coded *OVERCONFIDENCE* only after executive Z demonstrates overconfidence, we could have cases where *OVERCONFIDENCE* varies within executive Z's tenure in the firm (i.e., no variation in *OVERCONFIDENCE* due to turnover). Consider the case where the executive exhibits overconfidence in the third year of her tenure with FIRM1. Waiting until the third year to code her as overconfident would create variation in *OVERCONFIDENCE* within FIRM1, despite no change in CEO (i.e., in the absence of an exogenous shock).

4.3 Alternative measures of overconfidence

We rely on stock option exercise behavior to identify CEO overconfidence, following the bulk of research in the area. We further assess the robustness of our results by examining non-options-based measures. Accordingly, we replace our options-based measure with eight alternative proxies for CEO overconfidence. These include a measure based on CEOs' stock purchasing (*Net Purchase*), measures based on investments and acquisitions, and firms' capital structure choices (*Over-Invest_1*, *Over_Invest_2*, and *OC_FIRM5*, per Schrand and Zechman 2012), a measure based on factor analysis of five overconfidence measures used in our paper (*Factor_5*),[21] and a measure based on news articles in Factiva that report a CEO as being confident or less confident (*Press*). A final alternative proxy for executive overconfidence, the propensity for firms to miss their own earnings forecasts, comes from Dyreng et al. (2010), who examine whether executive fixed effects can account for tax avoidance incremental to firm and industry controls. Hribar and Yang (2016) show that CEO overconfidence is associated with the propensity for firms to miss their own earnings forecasts. Accordingly, we include this proxy that we label *Miss* in our tests of alternative overconfidence measures. We compute these measures at the CEO level, which facilitates use of our exogenous turnover design, except for *Press* which is a dynamic CEO-level variable consistent with prior studies. Additional details on each measure are provided in the appendix.

We present the results of these tests in Panel A of Table 7. The coefficient directions are all consistent with our expectations, and with one exception, these coefficient estimates are statistically significant below $p = 0.10$. The weaker statistical significance on certain overconfidence proxies, such as *Miss*, could be explained by lower power or noise; such noise could also explain why Dyreng et al. (2010) find no evidence that *Miss* explains executive fixed effects on tax avoidance.[22] However, Dyreng et al. (2010) use a different research design, due to their interest in the broad research question of whether executives affect tax avoidance, making direct comparisons of results difficult.[23] Regardless, the results presented in Panel A of Table 7 indicate that our main result is robust to several alternative measures used in prior literature, consistent with a positive relation between CEO overconfidence and tax avoidance.

[21] *Factor_5* captures the common variation in *OVERCONFIDENCE*, *Net Purchase*, *OC_Firm5*, *Over-Invest_1*, and *Over-Invest_2*.

[22] There are at least two reasons why forecast error is likely a noisier proxy for executive overconfidence than the options-based proxies. First, all executives, regardless of their confidence, face a substantial probability of missing a forecast. In contrast, there is not a strong reason to believe that less-confident executives would have a strong inclination to leave in-the-money options unexercised. Hence the forecast-based measure might be less discriminating than the options-based measure. Second, overconfident executives might be willing to engage in more aggressive accounting, operating decision, or both (Schrand and Zechman 2012) to avoid missing forecasts, which would manifest in a lower likelihood of missing a forecast. This propensity to take aggressive actions might counter the propensity to make more optimistic forecasts, also making the forecast-based measure less discriminating.

[23] While our paper relates to the work of Dyreng et al. (2010), we have different research questions, research designs, samples, and overconfidence proxies.

4.4 Alternative sample restrictions

We explore the sensitivity of our main result to several sample restrictions. First, we delete the year 2001, which coincided with a recession. Second, we delete the year 2007, which coincided with the financial crisis as the final year of our sample. Third, we delete CEOs with less than five years of option data. Fourth, we delete observations in the first full year of CEO tenure. Fifth, we delete firms with only one year of data before or after CEO turnover. Sixth, we require at least three or more years with the same CEO per firm before and after turnover to ensure our results are not driven by interim CEOs, who could occur in our setting where unexpected CEO changes do not allow for a lengthy search or grooming of a successor. If temporary CEOs are driving our results, then we would find no results when requiring a longer CEO time series of data as in this test. Seventh, we restrict our analysis to years three through five years before and after turnover. As summarized in Panel B of Table 7, our inferences are unchanged by these sample restrictions.

4.5 CFO tests

Our main analysis examines CEOs with the expectation that CEOs likely have the strongest influence on corporate strategy and are important in setting the tone at the top (Dyreng et al. 2010), a concept related to the upper-echelons theory widely studied in management research (Hambrick and Mason 1984; Hambrick 2007). Yet there are at least three important reasons to consider the role of the CFO in helping set corporate tax policy.

First, Dyreng et al. (2010) argue that CEOs are typically not tax experts and are likely to delegate tax policy decisions to CFOs.[24] If that assertion is correct, our main finding could be attributable to CEO overconfidence being correlated with CFO overconfidence. Accordingly, we assess whether CFO overconfidence is associated with tax avoidance and, if so, whether it subsumes the association between CEO overconfidence and tax avoidance. To do so, we supplement our main specification to include the indicator variable *OC_CFO*. We construct *OC_CFO* in the same way we construct *OC_CEO,*[25] so that our regressions will capture the average within-firm difference in tax avoidance for periods with overconfident CFOs, relative to periods without overconfident CFOs. If the effect of CEO overconfidence on tax avoidance were partly or fully subsumed by the effect of CFO overconfidence on tax avoidance, we would expect to see statistically weaker or insignificant coefficient estimates on *OC_CEO* and statistically significant coefficient estimates on *OC_CFO*. We present the results of this

[24] Armstrong et al. (2012) and Rego and Wilson (2012) suggest that tax directors are more directly related to the tax function than CFOs. Nevertheless, Rego and Wilson (2012) assert that the role of the CFO in financial reporting and in overseeing the maximization of after-tax cash flows suggests they could be important in setting corporate tax policy. Chyz and Gaertner (2017) present evidence that both CEOs and CFOs appear to be held accountable for tax outcomes. Although at least partially driven by a lack of endogenous turnover data for CFOs, their findings are considerably weaker for CFOs.

[25] *OC_CEO* is equivalent to *OVERCONFIDENCE* from our primary analyses. We merely change the variable name to make it easier for readers to interpret CEO and CFO effects separately. *OC_CFO* is measured consistent with the approached used to measure *OC_CEO*.

Table 8 CEO overconfidence, CFO overconfidence, and CFO newness

	CASH ETR		*TAX SHELTER SCORE*		*BTD_DD*	
	(−)		(+)		(+)	
Parameter	Coeff	Std Err	Coeff	Std Err	Coeff	Std Err
β_1: *OC_CEO*	−0.190	0.058***	0.056	0.013***	0.027	0.008***
β_2: *OC_CFO*	−0.019	0.093	−0.016	0.037	−0.009	0.017
β_3: *NEW_CFO*	−0.106	0.108	0.050	0.021**	0.026	0.015*
β_4: *OC_CEO*OC_CFO*	0.151	0.095	−0.023	0.034	−0.018	0.013
β_5: *OC_CEO*NEW_CFO*	0.160	0.120	−0.070	0.033**	−0.039	0.017**
β_6: *OC_CFO*NEW_CFO*	0.104	0.182	−0.035	0.053	−0.025	0.027
β_7: *OC_CEO*OC_CFO*NEW_CFO*	−0.387	0.202*	0.094	0.057*	0.056	0.026**
Controls	Yes		Yes		Yes	
Firm fixed effects	Yes		Yes		Yes	
Year fixed effects	Yes		Yes		Yes	
N	967		1071		1071	
R-squared	0.421		0.871		0.423	
	F-stat	*p* value	*F*-stat	*p* value	*F*-stat	*p* value
$\beta_2 + \beta_4$	3.48	0.064*	2.62	0.108	4.36	0.039**
$\beta_2 + \beta_4 + \beta_6 + \beta_7$	4.30	0.040**	0.32	0.571	0.15	0.700
$\beta_3 + \beta_5 + \beta_6 + \beta_7$	12.50	0.000***	3.80	0.053*	4.46	0.037**

This table presents the results of OLS regression analysis of tax avoidance on CFO overconfidence, CFO newness, and control variables. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively, for one-sided tests examining our empirical prediction and for two-sided tests for the remaining variables. *F*-tests on joint effects test whether the sum of coefficients is equal to zero. Standard errors are clustered by firm. *OC_CEO* and *OC_CFO* are indicator variables that capture the presence of an overconfident CEO and CFO, respectively. Overconfidence is measured consistent with previous tests. *NEW_CFO* is an indicator variable that equals 1 if there is CFO turnover in the same year as exogenous CEO turnover. Controls include all covariates included in Table 5. Variable definitions are found in the appendix

analysis in Table 8. We find that the coefficient estimates on *OC_CEO* remain statistically significant in the predicted directions, while the coefficient estimates on *OC_CFO* are not statistically significant. We also find that the joint effect of CFO overconfidence, as captured by an *F*-test on the sum of all coefficients in our model that contain *OC_CFO* ($\beta_2 + \beta_4 + \beta_6 + \beta_7$), is significant in the *CASH_ETR* regression but not the other two regressions. At most, these results provide only inconsistent evidence of an association between CFO overconfidence and tax avoidance.

Second, because of their relative expertise in tax, CFOs might serve as checks or enablers of CEOs influence over tax avoidance. The check role would occur when the CFO's confidence level fails to align with that of the CEO (i.e., either, but not both, the CFO or CEO is overconfident). The enabler role would occur when both are overconfident. We interact *OC_CEO* with *OC_CFO* to empirically investigate these roles. An alignment in confidence between CEOs and CFOs and hence an enabler role for the CFO would be evident in the joint effect of *OC_CFO* and the interaction term *OC_CEO*OC_CFO*. *F*-tests on the sum of these coefficient estimates ($\beta_2 + \beta_4$) do not provide support for the enabler role. In the case of *TAX_SHELTER_SCORE*, the joint test is not statistically significant. In the case of *CASH_ETR* and *BTD_DD*, the sum of the coefficient estimates and joint test suggests pairing overconfident CEOs with overconfident CFOs is associated with less (not more) tax avoidance, which is not consistent with an enabler role. With the inclusion of the interaction between *OC_CEO* and *OC_CFO*, the coefficient on the main effect of *OC_CEO* should capture instances of the check role where the CEO is overconfident but the CFO is not (i.e., overconfidence is not aligned). Because this main effect coefficient estimate remains statistically significant, even with the inclusion of the interaction term *OC_CFO*OC_CEO*, we interpret the results as providing no evidence of a check role for the CFO.

Third, although we do not document evidence of an enabler or check role for the CFO, the impact of CEO overconfidence on tax avoidance may be more pronounced when the CFO is linked more tightly with or is more beholden to the CEO. We expect that a stronger linkage will occur when the CEO has hired the CFO. Hence we assess whether the relation between CEO overconfidence and tax avoidance is magnified by the presence of a newly hired CFO. We capture the presence of a newly hired CFO with the indicator variable *NEW_CFO*, which takes the value 1 if the CFO was hired in the same year as the exogenous CEO turnover. We interact *NEW_CFO* with our other variables for transparency and to allow for an assessment of both incremental and joint effects. The positive and statistically significant coefficient estimates on the interaction term *OC_CEO*NEW_CFO*, when our dependent variables are *TAX SHELTER SCORE* and *BTD_DD*, provide some support for the assertion that the presence of a beholden CFO magnifies the relation between CEO overconfidence and tax avoidance. In addition, joint tests on all coefficients containing *NEW_CFO* ($\beta_3 + \beta_5 + \beta_6 + \beta_7$) are statistically significant and consistent with greater tax avoidance across all three regressions. This suggests that the impact of CFO overconfidence is most pronounced when the CEO brings in a new CFO.

4.6 Tax shelter revelations

To provide some anecdotal evidence that supports our empirical analysis, we searched for our sample firm-years in the tax shelter samples used by Graham and Tucker (2006), Wilson (2009), Hanlon and Slemrod (2009), and Brown (2011) and identified 29 firm-year observations of tax sheltering in our sample. Strikingly, 22 of these 29 instances involve overconfident CEOs, while only seven of the 29 instances involve non-overconfident CEOs, suggesting that firms with overconfident CEOs are more likely than other firms to engage in tax shelters that are eventually revealed. Beyond these instances, it is difficult to reliably identify specific examples of tax avoidance on a widespread basis, due in part to the fact that firms are naturally opaque with regard to tax avoidance (Gallemore et al. 2014). However, we believe that these instances of tax sheltering, combined with our more systematic but general evidence, show that firms with overconfident CEOs more aggressively avoid taxes than other firms. A caveat to this tax shelter sample is that it only includes tax shelters that were later revealed publicly, and we cannot observe tax sheltering that was not revealed.

5 Conclusion

Our study contributes to the tax avoidance, overconfidence, and manager effects literatures by examining the role of overconfident CEOs in influencing corporate tax policy. We identify exogenous variation in CEO overconfidence using a sample of exogenous CEO departures from Fee et al. (2013) and test for changes in tax avoidance as firms gain or lose overconfident CEOs. Using a measure of CEO overconfidence, based on observed option holding behavior and multiple measures of tax avoidance, we document a statistically and economically significant positive relation between CEO overconfidence and corporate tax avoidance. We confirm our results using various additional control variables, sample restrictions, and alternative measures of overconfidence. Further, evidence from a broad sample containing both endogenous and exogenous CFO changes suggests that the combination of overconfident CEOs and newly hired, overconfident CFOs contributes to corporate tax avoidance. Our results suggest that top executives' personality traits do indeed affect corporate tax policy. Our study thus provides evidence in support of the managerial effects literature, using a setting that is less susceptible to the critiques that follow the Bertrand and Schoar (2003) methodology used in much of this literature. Our findings should also be of interest to capital market participants and other academics who are interested in tax avoidance and CEO overconfidence.

Using the Fee et al. (2013) data has some benefits and some costs. Exogenous CEO turnover events improve our ability to identify and isolate the impact of CEO overconfidence on tax avoidance. However, exogenous turnover events are not common, and our dataset is not large. This potentially reduces both the generalizability of our results and the power of our tests. While our tests document evidence of overconfidence impacting tax avoidance, we provide only limited evidence of the specific mechanisms that drive our results. We also note that it is unclear whether the CEO overconfidence effect that we document arises from overestimation of the returns to

investments in tax policy choices, underestimation of the associated nontax costs, or a combination of the two. In either case, it could be that overconfident CEOs face future negative tax consequences when the true nontax costs and returns to investments in tax avoidance are revealed. We have also remained agnostic with respect to the firm value implications of our findings. Data limitations also prevent us from investigating whether overconfident CEOs are more inclined to rely on or change external tax advisors. These are all unanswered questions and issues that could be addressed in future research.

Acknowledgements We thank Edward Fee, Charles Hadlock, and Joshua Pierce for allowing us to use their exogenous CEO departure data. We are thankful for helpful comments from two anonymous reviewers, Brad Blaylock, Scott Dyreng, Paul Fischer (editor), Sandy Klasa, April Klein, Alok Kumar, Clive Lennox, Ed Maydew, Brian Mayhew, Lil Mills, Mark Peecher, Leslie Robinson, Terry Shevlin, Richard Taffler, members of the University of Connecticut Tax Reading Group, members of the University of Texas Tax Reading Group, workshop participants at the University of Kentucky, and attendees at the 2014 NTA Annual Meeting, 2014 Accounting Conference at Temple University, and 2014 Behavioral Finance Working Group Conference (University of London). A prior version of this paper benefited from useful comments from Dan Givoly, Michelle Hanlon, Rick Laux, and Karl Muller. We are thankful for the financial support from the University of Tennessee (Chyz); University of Wisconsin-Madison (Gaertner); American University (Kausar); Luciano Prida Sr. Term Professorship, Fisher School of Accounting, and Warrington College of Business (Watson).

Appendix: Variable definitions

Variable	Description	Construction
CASH ETR	Cash effective tax rate	TXPD/PI
TAX SHELTER SCORE	Estimated tax shelter probability	Following Wilson (2009), $\frac{1}{1+e^{-(\alpha+\beta X)}}$, where $\alpha + \beta X = -4.30 + 6.63*BTD - 1.72*Leverage + 2.26*ROA + 1.62*ForeignIncome + 1.56*R\&D$
BTD_DD	Residual book-tax differences	Following Desai and Dharmapala (2006), the residual from: $BTD_{i,t} = \beta_1 TA_{i,t} + \mu_i + \varepsilon_{i,t}$
OVERCONFIDENCE	Executive overconfidence	(OPT_UNEX_EXER_EST_VAL / OPT_UNEX_EXER_NUM) / (PRCC_F – (OPT_UNEX_EXER_EST_VAL / OPT_UNEX_EXER_NUM))
CASH FLOW	Cash return on assets	(OANCF+TXPD)/AT
LEVERAGE	Leverage	(DLC + DLTT)/AT
NOL	Net operating loss carryforward indicator	Indicator variable equal to 1 if TLCF >0, and 0 otherwise
ΔNOL	Change in net operating loss carryforwards	$(TLCF_t - TLCF_{t-1}) / AT_t$
FOREIGN INCOME	Foreign return on assets	PIFO/AT
PP&E	Property, plant, and equipment	PPENT/AT
INTANGIBLES	Intangible assets	INTAN/AT
EQUITY INCOME	Equity income in earnings	ESUB/AT
SIZE	Firm size	Natural log of AT
	Market-to-book ratio	(PRCC_F*CSHO)/CEQ

MARKET-TO-BOOK RATIO		
R&D	Research and development expense	XRD/AT
DISC_ACC	Performance-adjusted discretionary accruals	Following Dechow et al. (1995), the residual from: $TA_{it} = \alpha_0 + \alpha_1 /ASSETS_{it-1} + \alpha_2 \Delta SALES_{it} + \alpha_3 PPE_{it} + \alpha_4 ROA_{it} + \varepsilon_{it}$
COMP_OPTION	Ratio of stock option grant value to total compensation	OPTION_AWARDS_BLK_VALUE/TDC1
DELTA	Sensitivity of executive wealth to stock price changes	Delta per Core and Guay (2002)
VEGA	Sensitivity of executive wealth to changes in stock price volatility	Vega per Core and Guay (2002)
VESTED	Percentage of options vested	OPT_UNEX_EXER_NUM/CSHO
TENURE	Executive tenure	Number of years CEO has been in CEO position in a given firm
Additional Control Variables Used in Robustness Checks:		
ABILITY	Managerial ability	*MASCORE* per Koester et al. (2016)
NARCISSISM	CEO narcissism	*NarcScore* per Olsen and Stekelberg (2016)
MISSING_NARCISSISM	Missing CEO narcissism indicator	Indicator variable equal to 1 when *NARCISSISM* is missing, and 0 otherwise
STOCK_OWN	Percentage of stock owned by CEO	SHROWN_EXCL_OPTS/CSHO
HELD_PCT	Institutional ownership	Outstanding shares held by 13f institutions from Thomson Financial / CSHO
INVEST	Capital expenditures	CAPX/AT
LITSCORE	Litigation risk	Litigation risk per Kim and Skinner (2012) using industry, size, growth, and return volatility
CSCORE	Accounting conservatism	*C_Score* per Khan and Watts (2009)
ANNRET	Stock returns	Contemporaneous compounded annual stock returns from CRSP
P_TAX_AGG	CEO's personal tax aggressiveness	*SUSPECT_EXEC* per Chyz (2013)
EXER_HOLD	Exercise-and-hold indicator	Executives that have ever engaged in an "exercise-and-hold" stock option transaction per Chyz (2013)
Alternative measures of Overconfidence:		
Net Purchase	Overconfidence based on CEO stock purchase activity	*Purchase* per Ahmed and Duellman (2013)
OC_Firm5	Overconfidence based on five firm-level factors	*OC_FIRM5* per Schrand and Zechman (2012)
Over-Invest_1	Overconfidence based on overinvestment	*XSINVEST_INDADJ* per Schrand and Zechman (2012)
Over-Invest_2	Overconfidence based on overinvestment	*ACQUIRE_INDADJ* per Schrand and Zechman (2012)
Factor_5		Single factor created from factor analysis capturing the common variation in

	Overconfidence based on factor analysis of five factors	*OVERCONFIDENCE*, *Net Purchase*, *OC_Firm5*, *Over-Invest_1*, and *Over-Invest_2*
Overconfidence_2	Alternate measure of overconfidence	Same as *OVERCONFIDENCE* except that *Overconfidence_2* is set to 1 only for years after the first observance of overconfident behavior
Press	Press-based measure of overconfidence	A measure based on news articles in Factiva that report a CEO as being confident or less confident. Press takes on a value of 1 if the number of confident references exceed non-confident references; zero otherwise
Miss	Overconfidence based on forecast error	*OVERCONFIDENCE IN FORECASTS* per Dyreng et al. (2010)

All variables are measured annually at *t*

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