How Executive Compensation Changes In Response To Personal Income Tax Shocks (Who Pays The CEO's Income Taxes?)

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We quantify the effects of personal income taxes on executive compensation in the US. Controlling for other determinants of compensation and addressing endogeneity concerns, CEOs receive an abnormal increase in pay of 6.4% to 7.4% following large state income tax increases, relative to pay growth of CEOs who do not experience such tax shocks. Pay increases within two years by an amount that more than fully compensates the CEO for the increased tax liability. The increase in pay is larger when: there are more employment options in the industry and the CEO is less tied personally to the company; the firm is more profitable and the CEO-firm match is more valuable; and governance is doubtful (high E-index, low board independence). In stark contrast, CEOs and other NEOs do not experience a cut or slower growth in pay following a tax cut. The asymmetry in the income tax effect and the size of the response to increases suggest that both supply-demand considerations and agency concerns associated with rent extraction affect the change in CEO pay.

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1. Introduction

The level and structure of executive pay are complex, controversial concerns. Persistent interest among investors, regulators, politicians, and executives has spawned a substantial scholarly literature as well as a considerable compensation consulting industry. Both address the determinants and consequences, economic and otherwise, of the level and incentive properties of executive pay.

Per Edmans, Gabaix, and Jenter (2017), in their survey of the theories and empirical evidence on managerial compensation, the various empirical designs arise from at least three, non-mutually-exclusive perspectives: shareholder value maximization; rent extraction by executives; and institutional forces. The focus in the literature has been on the first two perspectives.

> Most recent analyses of executive compensation have focused on efficient-contracting or managerial-power rationales for pay, while ignoring or downplaying the causes and consequences of disclosure requirements, **tax policies**, accounting rules, legislation, and the general political climate. (Murphy, 2013; emphasis added)

We emphasize this third line of inquiry, in part as a means to examine the other two.

Several prior studies that have examined income taxes and executive compensation report negligible effects of US *federal* income tax policy on managerial pay (Goolsbee, 2000a; Hall and Liebman, 2000; Rose and Wolfram, 2002). Frydman and Molloy (FM, 2011, p. 1434) conclude that "(I)n summary, we have found little evidence that changes in tax rates are related to changes in executive pay…". Given the finding that federal income tax shocks have negligible effects, a plausible initial view is that there would be no change in executive pay in response to a change in personal state income tax.

We argue instead that state tax rate changes are fundamentally different. Federal tax shocks apply uniformly across all states to all U.S. executives, thereby eliminating outside employment options in other states that would avoid the tax change. The employment options that would circumvent a federal personal income tax increase would require relocation to a foreign country with a lower national personal income tax rate. In contrast, for US state personal income tax shocks the threat of relocating to a US state with a lower personal income tax rate is more likely to be credible. Differences across states in rates can be substantial. For example, in 2018 California's top marginal rate was 13.3 percent, as compared no state personal income tax in Texas, Florida, and several other states. Furthermore, it appears that top executives are attuned to such differences in state tax rates and will threaten to relocate or actually will relocate.[1]

We reject the null hypothesis of no effect on CEO pay. Our analysis indicates that the response of CEO compensation to state personal income tax increases is economically and statistically significant. Moreover, the size of the pay increase depends on supply and demand considerations, such as outside employment opportunities for CEOs, as well as agency concerns and rent extraction. The effect is asymmetric. Tax increases lead to compensation increases, while tax decreases have no effect on pay for CEOs and other named executive officers.

To further frame our analysis, suppose that top executives and firms are assortatively matched based on attributes of each that are reciprocally-synergistic, costly-to-transfer, and differentiated (Rosen 1981; Tervio 2008; Pan 2017). Then there are several reasons why a change in personal income tax rate would affect the level of executive pay. First, higher income taxes can directly

[1] See https://www.bizjournals.com/sanfrancisco/news/2020/11/17/california-exodus-roared-on-even-before-covid-hit.html and https://www.wsj.com/tech/elon-musk-to-discuss-teslas-banner-year-despite-pandemic-silicon-valleys-future-11607449988. Moreover, top athletes in team sports have limited locational flexibility but are acutely aware of how income tax rates vary across jurisdictions. For an example, see reporting on NHL hockey players (https://www.wsj.com/sports/hockey/stanley-cup-low-tax-states-florida-panthers-7d15ecff?mod=hp_featst_pos4).

reduce executives' after-tax income, thereby shifting the supply curve for executive input inward, which would imply upward pressure on CEO pay, especially if the demand curve for CEO input is inelastic. The version of the supply curve we have in mind includes both the intensive and extensive margins, though we think of the intensive margin as largely irrelevant. CEOs have significant span of control and demands on their time and rise to the apex of the organization because they supply maximal feasible managerial input. The participation decision, in contrast, is likely to matter. By this we do not mean whether the CEO decides to leave the labor market. Rather, as intimated above, the location and shape of the supply curve will depend on the external opportunities, *if any*, the CEO has for top management positions at employers offering higher pay, or in alternative low-tax domiciles, and on the frictions, benefits, and costs to the CEO of switching.[2,]

Second, in the matching model some will prefer to understand the determination of pay in the transaction cost economics (TCE) framework. Again, think of firm and executive "endowments" matched based on the potential reciprocal synergies arising from the characteristics and capabilities of the firm and manager. This bilateral dependency can create a one- or two-sided holdup problem. Therein specific firm assets and a particular manager's specific human capital cannot generate surplus without the other, so that an asymmetry in power can be ascribed to one of the firm and manager (Hart and Moore, 1990).

Third, and in addition, governance considerations likely affect the ability of the matched CEO to extricate additional pay. Perhaps the firm is not disposed to implement appropriate governance

[2] More generally, migration associated with tax differentials or changes in tax differentials does occur. Estimates of lost (gained) adjusted gross income due to interstate migration away from (to) high-tax (low-tax) states include the following: New York lost $111 billion in AGI; California lost $102 billion; Illinois lost $63 billion; Florida gained $196 billion; and Texas gained $54 billion. See https://www.ntu.org/foundation/detail/florida-continues-to-attract-new-residents-new-york-california-and-illinois-lose-the-most-population.

that would hold the CEO's feet to the fire. Or perhaps the costs of discovering and achieving an optimal governance structure potentially are prohibitive. In either case, for example, the board of directors could be co-opted (Coles, Daniel, and Naveen, 2014) or insufficiently independent (Weisbach, 1988) or the sensitivity of CEO pay to firm performance could be suboptimal. And even if governance mechanisms are optimally configured, the presence of informational or other frictions implies second-best solutions (Holmstrom, 1979) resulting in a "residual loss" (Jensen and Meckling, 1976). In this setting, governance permitting, executives potentially can exercise influence or power to increase their pay over and above what would arise from the conventionally understood intersection of supply and demand.

Over the 1992 – 2022 period there were 371 changes in the top marginal US state personal income tax rates, of which 116 were increases and 255 were decreases. Following Heider and Ljungqvist (HL, 2015), we focus primarily, though not exclusively, on the 46 "large" state tax rate shocks, meaning rate changes at least as large as one percentage point, including 27 tax increases and 19 tax cuts, in our sample (see Fig. 1). This approach is consistent with the possibility that large tax changes are more salient than small ones and that the costs associated with adjusting compensation in response to very small income tax rate changes are large relative to the benefits.

We apply two empirical approaches to the question of the effect of state personal income tax changes on pay. First, we apply a difference-in-differences (DiD) approach to state income tax shocks. Second, following the prior literature on federal income tax changes (e.g., Frydman and Malloy, 2011), we estimate the elasticity of CEO pay in the net-of-tax rate.

In our DiD specifications, we use state-level personal income tax changes as plausibly exogenous shocks to tax rates. Compared with federal tax changes, state-level changes in personal income taxes are more frequent and do not affect all states at the same time. The staggered nature

of state-level personal tax shocks potentially provides valid control firms as a set of counterfactuals for how executive compensation would have evolved without the tax changes. The treated group includes CEOs of firms headquartered in states experiencing increases or decreases in top personal income tax rates. The control group includes the remaining CEOs in the sample. Because states can and do experience repeated tax shocks, we define our treatment variable to indicate the appearance of each tax shock, while using the first difference of control variables on the right-hand side (per Heider and Ljunqvist, 2015).

Our estimates show that CEOs receive economically and statistically higher pay two years after a large (≥1%) increase in personal income tax rates. CEOs receive an extra increase in pay of 6.4 - 6.6% or as high as 7.2 - 7.4% following large tax increases, relative to CEOs who do not experience such tax shocks, controlling for other determinants of compensation. The 6.4 - 7.4% pay increase is larger than the 3.40% increase in pay that on average would make the CEO whole after a 1.95% mean state tax increase. On average, the CEO is more than fully compensated for a state personal income tax increase. Furthermore, the effect is asymmetric. In contrast to tax increases, the effect of a state income tax cut is statistically and economically insignificant. Thus, regardless of the direction of the change in tax rate, on average the CEO is never a loser.

The DiD results survive various hurdles for credible identification. First, we estimate stacked DiD (Cengiz et.al., 2019; Baker, Larcker, and Wang, 2022). The cost to this approach is the reduction in sample size. Due to the construction of a clean stack where multiple shocks are not allowed within each stack window, the usable data includes fewer than half of large state tax shocks. Despite the smaller sample size, our estimates and conclusions are robust to using stacked DiD. Second, we investigate whether state tax changes arise from prior rapid growth in executive pay. They do not. Third, we further remove political considerations by performing our tests using

only exogenous tax shocks, as determined using a narrative approach (Romer and Romer, 2010; Giroud and Rauh, 2019). Our findings are the same.

Fourth, a potential concern is that both state tax changes and executive pay changes can be affected by local economic conditions. Our baseline setting includes control firms that are not geographically proximate to the corresponding treated firms. Exploiting the fact that local economic conditions tend to be more similar in bordering states, we use a control group including only CEOs of firms headquartered in bordering states that do not experience any tax shock. This neighboring control group establishes the counterfactual response of CEO compensation to the unobserved local factors excluding the effects of tax changes. The effect of state tax changes on CEO pay is robust to the bordering-state setting. Fifth, the treated and control groups appear to have parallel trends in CEO pay changes before both positive and negative shocks to tax rates. Finally, we assess and then discard the possibility that our results on tax increases are attenuated towards zero by CEOs who avoid a state tax increase by a change in or the original choice of domicile.

We provide several triangulating results. First, named executive officers (NEO) who are not the CEO and are likely to have a lower ability to extract rents in the given governance setup receive a much smaller pay increase of about 2.5%, about one-third to three-eighths of that of the CEO, in response to a large increase in personal income tax rate. Like CEO pay, NEO pay does not decline in response to a tax decrease. Second, the size of the pay response to a large state income tax change depends on governance, with a larger pay increase assigned when the board is less independent and when the entrenchment index (E-Index per Bebchuck et al., 2009) is high. Third, the pay increase is larger when the CEO has more outside options (more CEO slots in the industry) and is more disposed to exercise the outside option (non-founder). Fourth, the pay increase is

larger when the firm has higher cash flow and high market-to-book ratio (MTB). We interpret the latter as indicating that the CEO has more power than the firm in the holdup problem.

Finally, directly analogous to our DiD analysis of US state income tax changes, we collect *international* data on staggered national income tax shocks across 20 additional countries. We find that CEO pay increases by about 8.3% the second year following a national personal income tax increase. Our preferred interpretation is that mobility frictions do not appear sufficient to fully undermine the credibility of the cross-border outside option to relocate to another country with a lower income tax rate. Nonetheless, while these estimates based on international mobility appear to be large, when normalized by the size of the tax changes the response to US state personal income tax shocks is larger than to national income tax shocks. Finally, like state income tax decreases in the US, we find that national income tax decreases across the sample of 21 countries do not lead to slower growth in CEO pay relative to benchmark.

For our second empirical lens, we follow the approach in FM (2011) to regress the natural logarithm of the change in managerial pay on the logarithm of the inverse of the ratio of post-tax-change (year *t*) *net-of-tax rate* (*NOT*) to the pre-tax-change (year *t-r*) net-of-tax rate, specifically $(1-\tau^{F}_{m,t-r}-\tau^{St}_{m,t-r})/(1-\tau^{F}_{m,t}-\tau^{St}_{m,t})$. The superscript denotes the federal (*F*) or state (*St*) personal income tax rate, *m* indexes the manager/CEO, and *t* and *t-r* index time. Controlling for other factors that would affect the rate of change in executive pay, an estimate of the coefficient on the log of the NOT equal to 1.0 would indicate that the proportional change in executive pay exactly offsets the tax increase, making the executive whole after-tax and fully shifting the incidence of the tax increase to the firm. Based on our estimate from the full sample of all state tax shocks, when the NOT changes by 1% due to a state personal income tax shock, CEO pay changes by 0.730% to 0.906%. These estimates imply that CEO pay increases within two years

by an amount three-quarters or more of the way to fully compensating the CEO for the increased tax liability. Consistent with the incidence of the state personal income tax shock, the estimates of the elasticity of CEO pay in the net-of-tax rate indicate that the supply curve for CEO services is at least 2.70 times and perhaps as much as 9.64 times as elastic as the CEO demand curve.

If instead allow the estimates for tax increase versus tax decreases to differ, the estimate of the elasticity in the NOT for state income tax increases becomes quite large. A 1% increase in the CEO's net-of-tax rate for large tax changes is associated with as much as a 2.762% increase in total compensation two years later, far more than the 1% that would be required to fully compensate the CEO for the state income tax shock. Furthermore, the downside elasticity, based on decreases in state income tax rates, is economically and statistically insignificant. Both of these results indicate that governance is imperfect and that CEOs possess and apply influence and power in the pay setting process.

Our analysis of the effects of state personal income tax changes on executive compensation contributes to several intersecting segments of the literature. We use changes in state personal income tax rates to advance the literatures on: the determinants of the level and rate of change of managerial compensation; supply and demand and the extensive margin for executives in the managerial labor market; corporate governance and rent extraction; and the incidence of personal income taxes. We build on prior studies that address taxes and executive pay, including Bird (2018) and Perry and Zenner (2001), who examine the effects of changes in tax treatment of components of executive pay, and Goldman, Henley, and Lewellen (2024), who relate convexity in the personal income tax schedule to executive pay.

2. Empirical Design

We use two approaches to examine the changes, if any, in CEO pay in response to changes in top personal state and federal income tax rates. We estimate: (1) a DiD model for repeated treatments, which we describe just here; and (2) an elasticity (in the net-of-tax rate) model, which we describe and deploy later.

In a DiD analysis based on a single event, the treatment variable is usually set to one in years after the event (as illustrated in the upper panel of Appendix 2, Figure A1). In our analysis, however, there are multiple shocks to tax rates through time and there can be repeated shocks in one state. For example, one tax increase may be followed by another tax increase or decrease in the same state in the future. In this case, a single treatment dummy equal to one after the first shock would fail to capture the subsequent shocks (lower panel of Figure A1).

One way to accommodate repeated events is to set the treatment variable as a count variable, or equivalently, use the first differences of all variables (including the treatment variable) in the DiD analysis (HL 2015).[3] Accordingly, we define a dummy variable, *Tax Increase* (*Decrease*), which equals one if a large tax increase (decrease) occurs in the headquartered state in a year, and zero otherwise, where a large tax change refers to a change greater than one percentage point. This is equivalent to the first difference of a count variable and captures all large tax shocks in a state (lower panel of Figure A1). In our DiD analysis we use the first differences of variables to estimate:

$$\begin{aligned}\Delta Ln(y_{m,t}) = \beta_0 \; &+ \beta_{-2}^{Incr} \cdot Tax\ Increase_{m,t-2} + \beta_{-1}^{Incr} \cdot Tax\ Increase_{m,t-1} \\ &+ \beta_{-2}^{Decr} \cdot Tax\ Decrease_{m,t-2} + \beta_{-1}^{Decr} \cdot Tax\ Decrease_{m,t-1} \\ &+ \Delta X_{m,f,t} \cdot \Gamma \quad + \mu_{m,f} + \vartheta_{ind,t} + \varepsilon_{m,t},\end{aligned} \tag{1}$$

[3] Our findings are robust to a stacked DiD approach, where one potential cost is to lose more than half large tax-increase shocks. The relevant results are reported in Appendix tables.

where the superscript *Incr* (*Decr*) indicates a coefficient for tax increase (decrease), and the subscript -2 (-1) indicates a coefficient for a tax shock two years (one year) ago. The other components on the right-hand side are defined as above. Again, $\Delta X_{m,f,t} \cdot \Gamma \quad + \mu_{m,f} + \vartheta_{ind,t}$ is meant to capture determinants, other than tax rate changes, of the change in CEO pay. The β coefficients show the treatment effects in the DiD analysis. For example, when y is CEO compensation, a significantly positive β_{-2}^{Incr} would indicate that CEO compensation increases two years following an increase in the state personal income tax rate.

We consider changes in CEO compensation both one and two years after shocks to top state (or federal) personal income tax rates. Benchmarking and pay-formation processes used by many listed US firms generally include lags in data and response. For new circumstances, such as state personal income tax shock in year *t*, the new compensation contract that responds to those circumstances will be effective no earlier than year *t+1* or perhaps more likely one more year later, in year *t+2*. Accordingly, we expect a lag of at least one year and more likely two years for a response, if any, to a change in the personal income tax rate.[4, 5]

3. Sample Construction

[4] The human resources director and board compensation committee, often in collaboration with a compensation consultant, set pay based on lagged pay data for size- and industry-based comparison firms and with a lag in pay determination based on those data (Murphy, 1999). The compensation consultant will collect compensation data on the various positions (CEO, CFO, SVP, Chief Legal Officer, Division Head, SVP, etc.) from those comparable companies and, as the benchmark, pick the median, mean or appropriate percentile, based on where the board determines the executive resides in effectiveness and performance relative to peer executives. To formulate contemporaneous benchmarks for setting pay, many firms apply an annual inflation factor, such as the 5% often suggested by compensation consultants, to the lagged benchmark data for overall pay and the components of pay.

[5] To elaborate further on timing, US personal income taxes in year *t* usually need to be paid by April (or no later than October) in year *t+1*, when any liquidity issue arises from the need to pay more income tax. The need for liquidity can motivate CEO option exercises and equity sales, which in turn can motivate the compensation committee of the board of directors to recalibrate the CEO's compensation contract which would come into effect the following year.

For the US sample, we obtain data on personal income tax rates from the official website of the Tax Policy Center (https://www.taxpolicycenter.org). CEOs generally have high income, so for any state we use the change in the top personal marginal income tax rate. As Panel A of Table 1 reports, over the period 1992 – 2022 there were 1,581 (= 51 x 31) state-years (including Washington, DC) and 371 changes in the top state personal income tax rate. Of these, 116 (255) were increases (decreases), while 46 (325) were large (small) changes of at least (less than) one percentage point.[6] Following Heider and Ljungqvist (HL, 2015), we focus primarily, though not exclusively, on the 46 large tax rate shocks, meaning rate changes at least as large as one percentage point, including 27 tax increases across 18 states and 19 tax cuts across 17 states in our sample (see Fig. 1). Treated firms are those headquartered in states experiencing large tax shocks. In our baseline setting, control firms are those headquartered in states without contemporaneous large tax shocks. As robustness tests, we also conduct some additional tests in which control firms never had any state income tax changes during the sample period.

Appendix 1 displays variable definitions. We obtain compensation data from Execucomp and corporate accounting data from Compustat. In our analysis we assume firms' executives live in the states where their offices are located.[7] We extract information on the location of firms' executive offices directly from SEC 10K filings. To identify the relevant state for personal income tax rates, we use the "Mail Address" in 10K filings, which is the HQ address or the "Address of principal executive offices" for the firm.

Our sample reflects the merged intersection of the Execucomp and Compustat datasets. We only include CEOs who have worked in their current positions more than two years, so that their

[6] For purposes of comparison, Panel A also reports on US federal tax changes.
[7] In 99.3% of cases in our sample the CEO owns a residence in the state where the corporate headquarter is located.

compensation in the current firms can be affected by the tax changes in the past couple of years and that CEO moves across firms do not contaminate the compensation data. Starting from 47,083 CEO-firm-year observations, we drop 12,745 because the CEO has less than 2 years of tenure, 5,765 by eliminating firms that change state of domicile, 425 when the firm has less than $50 million in market equity, and 5,857 from banks and utilities. Accordingly, over 1992–2022, the final sample includes 22,291 CEO-firm-year observations. Panel B of Table 1 reports additional summary statistics. About 2.6% and 1.3% (5.1% and 13.5%) of CEO-year observations reflect a large (small) increase or decrease, resp., in the CEO's top personal income tax rate.

For compensation measurement, we use the method described in Coles, Daniel, and Naveen (2013). We deploy their code[8] to calculate the value and incentive properties of cash, equity, and option awards to executives and the value and incentive properties of the accumulation of those awards (net of dispositions) as they comprise the executive's portfolio. The average CEO in our sample earns US$5.88M per year: $769K in salary, $335K in annual cash bonus; $837K in non-equity cash incentive pay; $1.97M in stock; $1.61M in options; and perquisites valued at $237K. In our tests we control for firm size (book value of assets), market-to-book assets, and CEO-firm performance (ROA),[9] as well as CEO-firm fixed effects and industry-year fixed effects. Firm-year averages in our sample are $6.489B for book assets, 2.189 for market-to-book assets, and 4.7% for ROA.

We also collect data for CEOs and their firms for national personal income tax rate changes in the US and 20 other countries. CEO compensation data are from Incentive Lab Europe, which

[8] See https://astro.temple.edu/~lnaveen/documents/deltavega_2013.sas. We thank the authors.
[9] An extensive literature in accounting and corporate finance establishes that these variables are related to the level and structure of executive pay. For examples, see: Smith and Watts (1992); Bizjak et al. (1993); Core et al. (1999); Murphy (1999); Coles et al. (2006); and Frydman and Malloy, (2011).

covers countries and regions including Great Britain, France, Switzerland, the Netherlands, Hong Kong, and Singapore. Panel C reports the summary statistics for the international sample including US and non-US firms. About 8.0% and 7.7% of CEO-year observations reflect a large increase or decrease, respectively, in the top personal national income tax rate faced by the CEO. The average CEO in this sample earns US$5.95M per year: $878K in salary; $98K in cash bonus; $1.15M in non-equity incentive pay; $2.83M in stock; $788K in options; and perquisites valued at $227K. The firm-year averages in our sample are $9.807B for book assets, 2.144 for market-to-book, and 4.5% for ROA.

4. DiD Analysis: The CEO Pay Response to Personal Income Tax Rate Changes

The primary treatment group is CEOs at firms in states with a personal state income tax shock greater than or equal to 1%, up or down. The "**base**" control sample is CEOs at firms in states that did not have a *large* personal state income tax shock. Because small changes in personal income tax rates are less likely to trigger pay negotiations between CEOs and their firms, CEO compensation in these states is expected to remain relatively unaffected, making them suitable candidates for the control group. A potential concern, however, could be that this control sample is not perfectly clean, as it includes CEOs in states experiencing contemporaneous but relatively minor tax shocks. Accordingly, following de Chaisemartin and D'Haultfoeuille (2020), as robustness tests, in some cases we also clean the base control sample further by eliminating CEOs in firms in states that had any small personal state income tax increase during the sample period. This removes 6,728 CEO-firm-year observations from the base control sample to yield a smaller (15,563) "**spotless**" control sample. The dependent variable is Δln(TDC1).

4.1. Large State Personal Income Tax Increases

Table 2 presents the results for the indicators for large tax shocks. Column 1 (2) shows the estimates of the effect on CEO compensation of tax increases (decreases) one year and two years prior. Column 3 includes indicator variables for both tax increases and decreases. The results show that CEO compensation significantly increases two years after a large tax increase. For example, controlling for other determinants of pay changes, column 1 (3) shows that CEO compensation increases by 6.4% (6.6%) two years after a state personal income tax increase, relative to normal pay growth based on firm performance, size, MTB, and factors captured by CEO-firm and industry-year fixed effects. We observe no significant changes in compensation in the adjacent lagged year of a tax increase. On average it takes two years for CEO pay to adjust following a tax increase.

These estimates for large state personal income tax shocks are based on the control sample that includes small state income tax shocks. To sharpen identification, at the cost of a less representative control group, we use the spotless control sample. Model 4 (6) of Table 2 indicates that CEO compensation increases by 7.2% (7.4%) two years after a state personal income tax increase. These coefficients are somewhat larger, with lower *p*-values, than those in models 1 and 3, even though using the spotless control sample reduces the number of CEO-firm observations from 22,291 to 15,563.[10, 11]

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[10] Using the intermediate control sample, which excludes state personal income tax shocks that occur within the three-year window starting with any large state tax shock, yields statistically significant estimates on the two lagged indicators of 6.6% and 6.7%. These figures, as well as the other parameter estimates, are similar in economic and statistical terms to those reported in Table 2. Moreover, for all of the results reported below, the estimates using the intermediate control sample are similar to those using the base and spotless control samples.

[11] Our findings are robust when using a stacked DiD approach (Cengiz et.al., 2019), as reported in Appendix Table A1 (pre-trends are illustrated in Appendix Figure A2). Specifically, for each large tax increase or decrease (at least 1%), a [-2, +2] stack window is constructed. States with any large changes (increases or decreases) at any point within a stack window are excluded. The results show that a significant pay increase appears only in two years following a large tax increase ($\beta_{-2}^{Incr} = 0.073$, $p < 0.001$), and no pay decrease is observed following a large tax decrease, consistent with the findings in our main analysis here and in the following subsection. Note that, in this stacked DiD setting, any state experiencing more than one large tax shock within a five-year window is excluded, which eliminates a substantial

We next investigate how personal income tax affects the components of CEO compensation. Figure 3 shows how the components of CEO compensation evolve over time, with stock pay becoming the largest component starting 2006. To examine the effects of large state personal income tax increases on the components of CEO compensation following tax increases, we estimate the following model:

$$\Delta Ln(yc_{m,t}) = \beta_0 + \beta_{-2}^{Incr} \cdot Tax\ Increase_{m,t-2} + \beta_{-1}^{Incr} \cdot Tax\ Increase_{m,t-1} + \Delta X_{m,f,t} \cdot \Gamma + \mu_{m,f} + \vartheta_{ind,t} + \varepsilon_{m,t}, \quad (2)$$

where *m*, *f*, *ind*, and *t* index the CEO, firm, industry, and year, respectively, *yc* is the component of CEO pay (annual salary and bonus, long-term cash bonus, stock, options), and other notation is the same as in Equation (1). Again, we include CEO-firm fixed effects and industry-year fixed effects to control for the CEO-firm match and time-series effects common to firms, managers, and industries.

Including controls and fixed effects, both long-term incentive plan (NonEqIncent) cash pay (Table 3, col. 3) and stock pay (col. 4) increase significantly two years following a large increase in the personal income tax rate. For the base (spotless) control sample, two years after a large tax increase, NonEqIncent cash pay increases by 10.9% (12.2%) and GDFV (grant date fair value) stock pay increases by 6.6% (6.0%), all else equal. In contrast, the associations between a state income tax increase and yearly salary, annual bonus, GDFV of options awards, and perquisites are negligible.[12]

share of shocks from our analysis. As a result, the sample includes only 12 large tax increases and 14 large tax decreases, compared with 27 increases and 19 decreases in the full sample, implying that more than half of the tax increases are omitted.

[12] Untabulated results indicate that CEOs do not abnormally sell shares after a state income tax increase. Thus, the increase in stock awards does not appear to be "replacement "grants.

4.2. Large State Income Tax Decreases

In stark contrast, there is no decrease in compensation following a tax decrease. As columns (2) and (3) of Table 2 report, the estimated coefficients on the lagged and twice-lagged tax decrease indicator variables are close to zero and insignificantly different from zero. See Figure 2.

The spotless control sample does not alter the finding of asymmetry. In models 5 and 6 the estimated coefficients on the lagged and twice-lagged tax decrease indicator variables continue to be economically and statistically insignificantly different from zero.

4.3. Robustness Tests: Further Evidence

4.3.1. Parallel Trends

We compare CEO pay changes [Δln(TDC1)] in the treated group and the control group in years around a shock (tax increase or decrease) to a state top personal income tax rate. In particular, we check whether the pay changes of the treated group are statistically different from those of the control group in years prior to the tax shocks. In each year relative to the event year, we calculate the CEO pay changes at the CEO-firm-year level (the dependent variable in our DiD regression analysis). We then take the yearly average within the treated and control groups, respectively, and calculate the difference between the two group-level yearly averages.

Panel A (B) of Figure 2 plots the yearly differences for large tax increases (decreases). The blue dots represent the average yearly differences in CEO pay changes [Δln(TDC1)] between treated and control groups. The upper and lower bounds of the bars show the 90% confidence intervals. Consistent with the parallel trends assumption, in years before the event year (year *t*), i.e. year *t-2* and year *t-1*, the differences between treated and control groups are not statistically different from zero. The figure also illustrates the pay differences two years following the large

tax increases. Consistent with the results in Tables 2, 5, and 6, CEO compensation increases (is unchanged) after a large state personal income tax increase (decrease).

4.3.2. Changes in CEO Pay Do Not Precipitate State Income Tax Rate Changes

We use state-level income tax changes as plausibly exogenous shocks to the tax rates to assess whether executive pay changes cause tax rate changes. The potential issue would be that high growth in executive pay could trigger regulatory intervention in the form of a higher marginal tax rate for high earners.

We regress the indicator *Tax Increase* (*Decrease*), which equals one if a state experiences an increase (decrease) in personal income tax rate greater than one percentage point in a year and zero otherwise, on CEO pay growth in a state one and two years prior, controlling for state characteristics including state debt, state GDP, tax revenues, cash savings, population, government indicator (democratic governor = 1, otherwise = 0), and unemployment rate. The test sample is at the state-year level and we include state fixed effects and year fixed effects. CEO pay growth is the average change in firm-level CEO pay within a state-year. We have the relevant data for 1997-2021.

Table 4 reports the results. The coefficients on CEO pay growth in the previous two years are not statistically significantly different from zero for both tax increases and decreases. State-level personal income tax changes do not appear to be associated with prior CEO pay growth in the states, which alleviates this endogeneity concern.

4.3.3. Exogenous Tax Shocks Identified by a Narrative Approach

Another potential concern is that omitted variables drive the relation between state personal income tax increases and CEO pay increases. Romer and Romer (2010) apply a narrative approach to classify tax changes larger than 1% into four categories based on the motivation of the tax

changes: (i) offsetting a change in government spending; (ii) offsetting some factor other than spending likely to affect output in the near future; (iii) dealing with an inherited budget deficit; and (iv) achieving some long-run goal, such as higher normal growth, increased fairness, or a smaller role for government. They define the last two categories as exogenous tax shocks. Giroud and Rauh (2019) use the same approach and study the effects of state taxation on the reallocation of business activity. Likewise, to form the treated group we include only the large tax shocks defined by the narrative approach as exogenous.[13]

Table 5 reports the results. The results indicate a somewhat larger pay response than reported in Table 2. In particular, using the base (spotless) control sample, CEO pay increases by 6.8% to 6.9% (8.1% to 8.3%) two years following a large increase in personal income tax rates. All four estimates are statistically significant. In contrast, there is no significant effect on pay for large tax decreases.[14] The findings in Table 2 are robust to using the narrative approach.

4.3.4. Neighboring Control States Without Tax Shocks

Local economic conditions potentially affect both executive compensation and local tax policies. Such effects are not necessarily removed in tests in which treated and control firms can be in different states far away from each other. To address this concern, we restrict control firms to be located in bordering states. Such states are more likely than distant states to share similar local economic conditions. For a treated state with a large tax shock, we include as control states only bordering states that do not experience a contemporaneous large shock to the personal income

[13] We thank Giroud and Rauh for making their classification of tax shocks publicly available. Their latest tax increases were in 2011. For the tax changes (greater than 1%) after 2011 in our sample, we manually collect the information and apply the narrative approach proposed by Romer and Romer (2010). The data are available from 1992-2021. The narrative approach identifies 38 out of the 46 large tax changes up to 2021 as exogenous tax shocks.

[14] The results are robust when using the stacked DiD approach, as reported in the Appendix Table A2.

tax rates (illustrated in Figure 4). This setting allows us to alleviate the concern about the effects of unobserved variation in local economic conditions.

Table 6 reports the results. The effects of tax increases on CEO pay remain positive and statistically significant [columns 1 and 3 (4 and 6) for the base (spotless) control sample], while the effects of tax decreases remain insignificant [columns 2 and 3 (5 and 6)].[15] The results in Table 2 are robust to using neighboring states to control further for local economic conditions.[16]

4.3.5. Distance to the Nearest Other State

In terms of neighboring states, assuming that in general a CEO must be proximate to corporate HQ for peak performance (Duchin and Sosyura, 2021), we interact the tax shock with the distance to the nearest state line. If that distance is large, it is less likely that the CEO is domiciled elsewhere (and thereby be insulated from the state tax shock). Then the estimated coefficient on the interaction term should be positive if the sample contains a material number of CEOs who are insulated from the tax shock. Columns 1 (base control sample) and 2 (spotless control sample) of Table 7 show that the interaction coefficient estimate is essentially zero.

5. How Large is the CEO Pay Response?

To get a better sense for the estimated size of the pay response, let $y_{m,t}$ be nominal period *t* compensation of CEO *m* and let $\tau_{m,t}^{F}$ and $\tau_{m,t}^{St}$ be the federal and state tax rates applicable to CEO *m* in period *t*. Assuming a flat tax, for simplicity, after-tax, period-*t* pay of the CEO of the firm is $y_{m,t} \cdot (1 - \tau_{m,t}^{F} - \tau_{m,t}^{St}) = y_{m,t} \cdot NOT_{m,t}$, where $NOT_{m,t} \equiv (1 - \tau_{m,t}^{F} - \tau_{m,t}^{St})$ is the "net-of-tax"

[15] Appendix Table A3 shows that these findings are robust when using the stacked DiD approach.
[16] We also perform robustness tests with neighboring states as control states in which we consider only tax shocks identified using the Romer and Romer (2010) narrative approach. The results are robust and available on request.

rate which, when applied to taxable income, determines after-tax income. Let $g_{m,t}$ be the growth rate for the pay of the CEO in market equilibrium in the absence of a tax shock. The rate $g_{m,t}$ can depend on firm accounting or market performance, size, asset tangibility, inflation rate, performance of industry competitors, other factors, and on CEO characteristics as well. Suppose that $(1 + g_{m,1})y_{m,0}$ is the appropriate benchmark for the CEO's pay in period 1, based on initial pay $y_{m,0}$, in the absence of any tax rate shock.

Now allow for income tax shocks. Let $\hat{y}_{m,1}$ denote the nominal pay of the CEO in period 1 that makes the CEO whole after-tax, holding all else constant: $\hat{y}_{m,1} \cdot (1 - \tau^{F}_{m,1} - \tau^{St}_{m,1}) = \left(1 + g_{m,1}\right) \cdot y_{m,0} \cdot (1 - \tau^{F}_{m,0} - \tau^{St}_{m,0})$, or identically, $\hat{y}_{m,1} \equiv \left(1 + g_{m,1}\right) \cdot (NOT_{m,0}/NOT_{m,1})y_{m,0}$. Then the abnormal (not accounted for in $g_{m,1}$) growth rate in CEO pay that exactly makes the CEO "whole" after the tax shock is given by $(NOT_{m,0}/NOT_{m,1}) - 1$.

For the average state income tax increase of 1.95%, assuming the average state income tax rate of 5.3% and a federal tax rate of 36.4%, that abnormal growth rate is given by (1 – 0.364 – 0.053 – 0.0195)/(1 – 0.364 - 0.053) = 1.0346, or an increase of 3.46%. The tax-shock-related CEO pay response of either 6.2-6.4% or 7.2-7.4% is substantially larger. On average the CEO is more than fully compensated for the state income tax increase.

Relative to normal growth in pay, the pay decline that would make the CEO whole, based on average federal and state rates of 36.4% and 5.3% and the average large state personal income tax rate decrease of 1.60%, is indicated by (1- 0.0364 – 0.053)/(1 – 0.364 – 0.053 + 0.016) = 0.9733. This implies a decrease of 2.67% in benchmark CEO pay based on firm size and performance. We find no such decrease in the data.

For state income tax decreases, note that a reduction in nominal pay would not necessarily be required, all else equal, to equate after-tax CEO pay before and after a tax reduction. Again, the specifications in Table 2 control for normal *growth* in pay associated with firm performance, size, and asset composition, so a negative estimate on the tax cut indicator would mean that the growth in nominal CEO pay (in response to a personal income tax cut) need not be negative but could only be slower than otherwise expected. Thus, while frictions in the pay-setting process for adjustment of nominal pay downward may be larger than for escalating pay, such is an unlikely explanation for the lack of a downward abnormal response to tax rate decreases when benchmark pay grows for other reasons.

6. Negotiation (Supply and Demand) Versus Governance/Agency Costs

One possible reason CEO pay is highly responsive upward to state personal income tax increases is that CEOs can threaten to quit. If the costs of relocating are low, then such a threat on the extensive margin is credible. The large, estimated response in CEO pay to a state income tax increase is consistent with low locational frictions and a credible threat by the CEO of moving to another job in a low-tax state.[17]

It also can be the case that in the case of asset specificity that the CEO has a hold-up advantage over the firm. For example, suppose the CEO's human capital is relatively valuable to the enterprise and hard to duplicate and the firm's capital is relatively duplicatable.

For high upward responsiveness of CEO pay and downward rigidity, CEO power and entrenchment immediately also arise as possible explanations. Some firms have relatively severe

[17] We thank Carola Frydman and Wayne Guay for bringing locational concerns to our attention.

agency conflicts. Holding the agency conflicts constant, some firms are worse at devising good governance. And, even if governance is optimally configured, the governance mechanisms in place can be insufficient to fully prevent second-best residual losses (Jensen and Meckling, 1976).

In this section we provide evidence on (i) CEO-firm negotiation (supply and demand) versus (ii) residual loss from CEO influence, profusion and rent extraction as potential explanations.

6.1. Bargaining: Supply and Demand at the Nexus of the Assortative Match

In terms of the threat to leave for another position in a low-tax domicile, CEOs can seek CEO positions (or take a demotion to CFO) in low-income-tax-rate states. Such locational considerations at the extensive margin determine the elasticity of the CEO's response, as a supplier of managerial input to the employer, to a state personal income tax shock. For example, if there are many firms in the industry, giving CEOs more outside options for higher pay, especially when a significant number of those firms are located in states that did not increase the personal income tax rate, the threat of relocation will confer on the CEO more negotiating power and the supply of managerial input will be more elastic. On the other hand, if the CEO is the founder of the firm and is attached to the firm for personal reasons, such as escalated commitment to the firm, then the threat of relocating is relatively empty.

Table 8 suggests that both of these hypotheses are supported in the data. Per model 1, the coefficient estimate (0.146, $p < 0.001$) on the interaction of the dummy variables for whether the CEO is **not** a founder of the firm and the lagged state tax increase is positive and significant. Likewise, in model 2 the estimate on the interaction of indicator variables for whether the number of firms in the industry exceeds the median in that year and for the positive lagged state tax shock is positive and significant (0.089, $p = 0.012$). Both results suggest that the availability of outside

employment options and the willingness to pursue those outside options are associated with a larger increase in pay in response to a state personal income tax increase.

Turning to the employer, if the firm generates high cash flow and is relatively unconstrained financially, the firm can be more willing to deploy funds for retention. Moreover, the CEO perhaps will argue that employees should share with shareholders and other employees in the larger pie.[18]

We interact the state income tax shock indicator with a dummy based on whether the firm is above or below the industry-level median profit margin [(Sales – COGS)/Sales] (two-digit SIC). Controlling for the change in firm performance, in model 3 (Table 8) the estimate on the interaction term of the dummies for the lagged state tax increase and for profit margin above the yearly median (0.070, $p = 0.091$) is positive and insignificant. The firm appears to not be persuaded by the CEO's putative argument,

If a firm's MTB ratio is high, the executive team presumably is managing the assets at a significant premium above book value. The unique, firm-specific skills and experience and potentially rare general human capital of the CEO are prime examples of intangible assets that contribute to market value. An executive with an extraordinary, valuable skill set is not easily replaced, creating a competitive advantage that investors recognize and value. In a firm with a high MTB ratio, the value of the incumbent is likely to be high relative to the next-best CEO match, in which case the firm will be more likely to respond to a tax shock with additional compensation. The evidence in favor is underwhelming. The parameter estimate on the interaction of the tax

[18] Moreover, a CEO in a more-profitable focal firm will be evaluated and benchmarked for pay relative to a more generous external benchmark based on comparison firms in the same industry that are similar in size and performance (Bizjak, Lemmon, and Naveen, 2008; Faulkender and Yang, 2010; Murphy, 1999).

shock and above-yearly-median MTB dummies is positive and only marginally significant (0.088, $p = 0.058$).

Comparing the firm and the CEO, it appears that locational opportunities and preferences of the CEO have more power than firm characteristics (such as profitability and MTB ratios) to explain the compensation responses to a state personal income tax increase. These results are consistent with a CEO supply curve that is more elastic than the firm's demand curve.

6.2. Agency and Rent Extraction: Governance

Poorly governed firms are more likely to capitulate to the influence or pressure applied by their CEOs. Poor governance provides a context for opportunism and rent extraction. For governance we use two conventional measures, the E-index (Bebchuk et al., 2009) and board independence (Weisbach, 1988). A higher value of the entrenchment index and a lower proportion of non-employee and other non-conflicted directors on the board are conventionally understood to indicate less effective governance.

In Table 9, the coefficients of interest are those on the interaction of the tax increase dummy and the measure of governance effectiveness. The estimates in the first two columns are positive and economically and statistically significant. An E-Index above the yearly median is associated with a 10.8% ($p = 0.003$) abnormal increase in pay two years following a large increase in the state personal income tax rate. Similarly, the estimate on the interaction of the lagged state personal income tax increase with a dummy for board independence being lower than the yearly median is 0.067 ($p = 0.049$).

6.3. Agency and Rent Extraction: NEO Pay Versus CEO Pay

We investigate the compensation tax effects for non-CEO named executive officers. In terms of the threat to leave for another position in a low-tax state, CEOs can seek CEO positions (or take

a demotion to CFO) in low-income tax states, while CFOs can seek CFO positions in other states and also, perhaps, move up into the role of CEO. In replacing a mobile executive, firms have about as many candidates for CEO positions as for CFO positions. Let us suppose that non-CEO NEOs have a similarly rich set of outside opportunities as CEOs. Then, if there is a difference in the extent to which a CEO versus a non-CEO NEO in the compensation response to the state income tax shock, it is more likely attributable to differences in the executive's influence, power, and ability to extract rents. Our hypothesis is that NEOs are less able to extract rents than CEOs.

Columns 1 and 2 of Table 10 show that the effects on non-CEO NEO pay of state income tax changes, both one and two years prior, are statistically insignificant. Column 3 shows that, for an increase in state tax rate, the estimate of the response in non-CEO NEO pay to a state tax increase is 2.5% ($p = 0.084$), about one-third to three-eighths of the response for CEOs, while decreases in the state tax rate have negligible effect on pay for both CEOs and other NEOs. In sum, tax increases (decreases) matter less (the same) for non-CEO NEO pay than for CEO pay. This suggests that CEOs possess additional ability, beyond that of other NEOs, to extract rents, under existing governance arrangements, whatever they may be, and that they utilize that ability to obtain a large upside response in CEO pay to a state income tax rate increase.

6.4. International Evidence

It is possible that CEOs have outside options for employment as a top executive in other countries with lower national income tax rates, though frictions of moving abroad are likely to be larger than moving to other regions within a country. We collect changes in the top national personal income tax rate for the US and 20 additional countries or regions across the 2011-2022 period. Those countries and regions are Belgium, Bermuda, Canada, the Czech Republic, Germany, Denmark, Spain, Finland, France, Great Britain, Hong Kong, Ireland, Israel, Italy,

Luxembourg, the Netherlands, Norway, Portugal, Singapore, and Sweden. Over the sample period there were 14 increases in 8 different countries and 9 decreases in 6 different countries. To remove potentially confounding effects of state tax shocks, we exclude US CEOs experiencing state tax changes.

We repeat the DiD analysis across for our data on the 21 countries. The results are displayed in Table 11. Like state tax shocks in the US, pay is unresponsive downward when the national tax rate declines. For national tax rate increases, the parameter estimates indicate a significant positive response two years after the tax increases. In our sample of CEOs and firms in 21 countries, CEO compensation increases in response to an increase in national income tax rates. These findings are consistent with the results in our main analysis based on US state personal income tax shocks.

To compare the response in pay for US state tax shocks versus international national tax shocks, we normalize by size of the tax change. The estimated coefficient is larger for international country-level tax shocks, likely because those shocks are substantially larger than US state tax shocks. We normalize the coefficients on the large state (Table 2) and national (Table 11) income tax indicators for size. The twice-lagged US state (international) coefficient estimate of 7.4% (8.3%) is 3.79 (versus 1.99) times the average US state (international) tax increase, 3.96 (2.08) times the median, and 2.51 (1.28) times the range of large tax shocks. The response in US CEO pay to US state tax increases appears to be larger per unit of tax rate increases than for international CEOs to national personal income tax rate increases. One likely reason is that outside employment opportunities for CEOs are more available in other states in the US than for CEOs across national borders. Moreover, the costs of relocating across borders for international CEOs likely would be larger than the costs for US CEOs relocating across states.

7. The Elasticity of CEO Compensation in Personal Taxes

To assess further the responsiveness of CEO pay to personal taxes, we estimate the elasticity of CEO compensation with respect to the factor that captures what is left after income taxes, the net-of-tax rate. Our elasticity formulation closely resembles that in the influential prior literature on federal personal income tax shocks (e.g., Frydman and Malloy, 2011; Goolsbee, 2000; Hall and Liebman, 2000; Rose and Wolfram, 2002). We consider both federal level and state level changes in personal income tax rates and address large tax shocks and large and small tax shocks together.[19]

7.1. The Elasticity Model

Let $y_{m,t}$ be nominal period *t* compensation of CEO *m* and let $\tau^{F}_{m,t}$ and $\tau^{St}_{m,t}$ be the federal and state tax rates applicable to CEO *m* in period *t*. Assuming a flat tax, for simplicity, after-tax, period-*t* pay of the CEO of the firm is $y_{m,t} \cdot (1 - \tau^{F}_{m,t} - \tau^{St}_{m,t}) = y_{m,t} \cdot NOT_{m,t}$, where $NOT_{m,t} \equiv (1 - \tau^{F}_{m,t} - \tau^{St}_{m,t})$ is the "net-of-tax" rate which, when applied to taxable income, determines after-tax income. Let $g_{m,t}$ be the growth rate for the pay of the CEO as determined in market equilibrium by factors other than taxes. The rate $g_{m,t}$ should depend on firm accounting or market performance, size, asset tangibility, inflation rate, performance of industry competitors, other factors, and on CEO characteristics as well. Suppose that $(1 + g_{m,1})y_{m,0}$ is the appropriate benchmark for the CEO's pay in subsequent period 1, based on initial pay $y_{m,0}$, in the absence of any tax rate changes.

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[19] The income tax in the US can include three parts: federal, state, and local. In contrast to federal and state income taxes, local income taxes are low (most local income tax rates are between 1% to 3%, with a few exceptions, including the District of Columbia, with the local income tax rate ranging from 4% to 8.5%). More information is available at https://taxfoundation.org/local-income-taxes-city-and-county-level-income-and-wage-taxes-continue-wane/. We approximate the income tax rate either as the federal rate or the sum of federal and state income tax rates and ignore local income tax.

Now allow for income tax shocks. Let $\hat{y}_{m,1}$ denote the nominal pay of the CEO in period 1 that makes the CEO whole after-tax, holding all else constant: $\hat{y}_{m,1} \cdot (1 - \tau^{F}_{m,1} - \tau^{St}_{m,1}) = (1 + g_{m,1}) \cdot y_{m,0} \cdot (1 - \tau^{F}_{m,0} - \tau^{St}_{m,0})$, or identically, $\hat{y}_{m,1} \equiv (1 + g_{m,1}) \cdot (NOT_{m,0}/NOT_{m,1}) y_{m,0}$. Dividing both sides by prior pre-tax pay, and allowing that tax rate changes can affect pay potentially with a lag, suggests the following specification to estimate the effect on CEO pay of a change in the personal income tax rate:

$$Ln\left(\frac{y_{m,t}}{y_{m,t-1}}\right) = \beta^{q}_{0} + \beta^{q}_{-2} Ln\left(\frac{NOT_{m,t-3}}{NOT_{m,t-2}}\right) + \beta^{q}_{-1} Ln\left(\frac{NOT_{m,t-2}}{NOT_{m,t-1}}\right) + \Delta X^{q}_{m,f,t} \cdot \Gamma^{q} + \mu^{q}_{m,f} + \vartheta^{q}_{ind,t} + \varepsilon^{q}_{m,t}, \tag{3}$$

where *m* is the CEO index, *t* is the time index, *f* is the firm index, *ind* is the industry index, *y* is CEO compensation, and $NOT_{m,t}$ is the after-tax rate as defined above. The superscript *q* = *St* signifies the data and parameter estimate are based on state personal income tax shocks, while *q* = *F* would indicate estimates are based on federal tax changes. In addition, Δ is the first difference operator (within CEO-firm), $X^{q}_{m,f,t}$is the vector of control variables (including characteristics of the firm that employs the CEO), Γ^{q} is the coefficient vector for the control variables, $\mu^{q}_{m,f}$ is the CEO-firm fixed effect, $\vartheta^{q}_{ind,t}$ is the industry-year fixed effect, and $\varepsilon^{q}_{m,t}$ is the error term. Some models require simpler fixed effects, such as for each of CEO and year. The control variables in *X* can be transformed using the natural logarithm function, scaled, or not transformed at all. We include the obvious control variables from prior literature. Here and throughout $\Delta X^{q}_{m,f,t} \cdot \Gamma^{q} + \mu^{q}_{m,f} + \vartheta^{q}_{ind,t}$, *q* = *St* or *F,* is meant to capture determinants, other than tax rate changes, of the change in CEO pay.

For state tax changes we expect the estimate of β_{-2}^{St} to be positive because an increase (decrease) in the state personal income tax rate implies an increase (decrease) in the inverse *NOT* ratio, $NOT_{m,t-3}/NOT_{m,t-2}$. If compensation responds sooner, β_{-1}^{St} should be positive. In any case, the estimated coefficient from Equation (1) is the **negative** of the elasticity of executive pay in the inverse net-of-tax rate, $-\beta_{-k}^{St} = \varepsilon_{y,NOT}^{St} \equiv (NOT/y)(dy/dNOT)$, where the superscript *St* on $\varepsilon_{y,NOT}$ indicates that the elasticity estimate is based on state tax shocks. The estimated coefficient would be opposite in sign if we perform the regression analysis based on $NOT_{m,t-k}/NOT_{m,t-k-1}$ rather than the inverse after-tax ratio used in Eqn. (3). Note that the effect of a state tax rate change on the inverse net-of-tax ratio depends on the level of the federal tax rate.

7.2. The Elasticity of CEO Compensation in the Net-of-Tax Rate: US Federal Tax Shocks

Frydman and Malloy (2011), using a sample of top executives in 50 large firms from 1946 to 2005, find very little response in the annual salary and bonus, qualified option grants, and total compensation of top executives, including some non-CEOs, to changes in federal tax rates on labor income. Other previous studies on the topic, relying in like manner on identification by time series variation within firms, report that changes in federal income tax rates have negligible effects on CEO compensation (Goolsbee, 2000; Hall and Liebman, 2000; Rose and Wolfram, 2002).

For purposes of a benchmark comparison with state tax shocks, we apply the elasticity approach from the prior literature to reassess the effects of federal personal income tax shocks on CEO pay in our more recent data. There are 6 large ($\Delta\tau^F \geq 0.01$) changes in the top US federal personal income tax rate in our sample period, ranging from -3.6% to 8.6%.

We exclude state tax changes from the inverse NOT calculations. Those state shocks, while generally much smaller than federal income tax shocks, allow some noise to remain in the analysis

of federal tax shocks.[20] If there is no federal tax shock, the inverse net-of-tax ratio will always equal 1 regardless of whether there was a state tax shock. Our reading of the prior literature is that those studies calculated the NOT based only on the federal tax rate.

The federal income tax applies to US CEOs regardless of location. If locational options are primary, the elasticity estimates would be negligible because of the absence of outside options in the US for US CEOs. Of course, a CEO could relocate to a different country with a lower national income tax rate. If such international options are pertinent for US CEOs, as they appear to be for CEOs across 21 countries (Table11), then we would expect the estimates on the ratio of net-of-tax rates to be positive. Furthermore, if agency problems and associated rent extraction are considerable the estimates again would be positive.

Table 12 reports estimates that are consistent with the prior literature. In all four specifications the estimates on the inverse NOT ratio lagged once are small and statistically insignificant. Frydman and Malloy (2011) in every specification confidently reject an elasticity of taxable compensation with respect to the net-of-tax rate greater than +0.200. Thus, our results are consistent with Frydman and Malloy (2011) and with the negligible effect of tax rates found by Goolsbee (1999) for tax reforms prior to 1986.[21] Furthermore, the estimates are consistent with the notion that outside locational options in other firms and rent extraction in the firm in question are not likely to be factors that escalate pay in response to a federal income tax increase.

7.3 The Elasticity of CEO Compensation in the Net-of-Tax Rate: US State Tax Shocks

We now compare the federal tax shock results to elasticity estimates based on state personal

[20] The results are similar if we do not exclude changes in the state personal income tax rate in the NOT.
[21] Goolsbee (1986) uses both the income share of high earners (based on the aggregate data from tax records) and executive compensation micro-data during the 1971–72 and 1935 tax reforms.

income tax shocks. Table 13 reports the results. We include the standard control variables and CEO-firm and industry-year fixed effects. Federal tax changes apply to all CEOs in a year and potentially are mostly washed away by time fixed effects.

Column 3 includes large and small state tax changes. It is possible that all tax rate changes, large or small, matter for CEO pay. The estimated coefficients on the inverse net-of-tax rate, however, are both statistically insignificant: β_{-2}^{St} = 0.405 (t = 1.20) and β_{-1}^{St} = 0.315 (t = 0.75). The sum of the two estimates is $\beta_{-2}^{St} + \beta_{-1}^{St}$ = 0.720, which is sizable but insignificant.

Columns 1 and 2 show the results for large ($\Delta\tau^{St} \geq 0.01$) salient tax rate changes. We remove small state tax shocks by setting the maximum state tax rate (and NOT) in the adjacent following year to be equal to the earlier of the two years. That is, for columns 1 and 2, which are focused on large shocks, we set $NOT_{m,t-k}/NOT_{m,t-(k-1)}$ = 1 for all observations for which the tax rate change was less than one percentage point. This immunizes the analysis of large state tax shocks from contamination by small state tax rate changes.

The estimates on the lagged response coefficients are β_{-2}^{St} = 0.906 and 0.730. That is, columns 1 and 2 indicate that a 1% decrease in the net-of-tax rate due to a state personal income tax rate increase is associated with a 0.906% (t = 2.30) or 0.730% (t =2.01) increase in total compensation two years later, respectively. Moreover, the sum of the coefficients on the lagged once and twice NOT ratios are 0.947 (column 1) and 0.826 (column 2). An estimate of 1 would be consistent with an increase in pay that makes the CEO exactly whole in terms of after-tax pay. Both estimates indicate that the CEO is substantially compensated two years later for a change in state personal income tax rate.

To illustrate further the economic significance of the parameter estimate, suppose the state personal income tax rate goes up by 0.0195 from period $t-3$ to $t-2$. Assume that prior to the

tax increase that the federal and state rates are the CEO-year averages in the sample, 36.4% and 5.3%, respectively, so the federal and state rates sum to 0.417 at $t-3$ and 0.437 at $t-2$. Then $Ln(NOT_{m,t-3}/NOT_{m,t-2})$ becomes 0.0349 rather than 0 (had there been no tax rate change) after the state tax increase. Using the elasticity estimates from columns 1 and 2 implies a 3.08% (0.906 x 0.0349) and 2.48% (0.730 x 0.0349) proportional abnormal (due to the tax shock) increase in CEO pay.

The evidence on rent extraction versus negotiating, as represented by supply and demand curves, is inconclusive. As Table 2 indicates, state personal income increases on average are followed by substantially larger changes than indicated by the elasticity estimates. A leading interpretation is that in the context of imperfect (though perhaps optimal) corporate governance CEOs have the ability and inclination to extract rents. Then, on the other hand, material rent extraction should appear in the federal elasticity estimates. It does not. The federal estimates are zero or slightly negative and they are insignificant.

If rent extraction is equally pertinent for federal and state tax shocks, the federal estimates suggest minimal rent extraction for state shocks as well. Then the primary reason for the large difference in the federal and state tax elasticity estimates should be the lack of the outside option for CEOs arising under the federal tax shocks. Accordingly, comparing Tables 12 and 13 suggests that outside options are an important reason for the responsiveness of CEO pay to state personal income tax changes, a conclusion that appears to be inconsistent with the large estimated DiD coefficients (Table 2).

7.4. Supply and demand elasticities for CEO input.

Along these lines, we consider whether there is a combination of standard supply and demand effects that accommodate the elasticity estimates. To do so we address whether the estimate of

$\beta_{-2}^{St} = -\varepsilon_{y,NOT}^{St}$ is consistent with plausible demand and supply conditions for CEO "labor" as a function of "wage." ($q = St$ indicates that the elasticity estimate of $\varepsilon_{y,NOT}^{St}$ is based on state personal income tax shocks.)

Denote equilibrium executive compensation as y, the sum of the federal and state tax rates as $\tau = \tau_f + \tau_s$, and CEO pay after income tax as $y \cdot (1 - \tau) = y \cdot NOT$. Denote the demand function of the firm for executive "labor" or input as $D(y)$ and the executive's supply function as $S(y \cdot NOT)$. In partial equilibrium in the executive labor market, $D(y) = S\big(y \cdot (1 - \tau)\big) = S(y \cdot NOT)$ determines the equilibrium level of compensation for a given net-of-tax rate.

Suppose that there is a shock to the net-of-tax rate. The shock could be an increase (a reduction) in federal or state tax rate, in which case NOT would fall (rise). To assess the effect of the tax shock on equilibrium pay, totally differentiate the expression equating demand and supply in y and NOT to get $D'(y) \cdot dy = S'(y \cdot NOT)[y \cdot dNOT + NOT \cdot dy]$. Rearranging gives $\varepsilon_{y,NOT}^{St} = -\varepsilon_S/(\varepsilon_S - \varepsilon_D)$, where $\varepsilon_{y,NOT}^{St} \equiv (NOT/y) \cdot (dy/dNOT)$ and the supply and demand elasticities in the CEO labor market are $\varepsilon_S \equiv y \cdot NOT \cdot S'(y \cdot NOT)/\, S(y \cdot NOT)$ and $\varepsilon_D \equiv y \cdot D'(y)/\, D(y)$. For $\varepsilon_S \in [0, \infty)$ and $\varepsilon_D \in (-\infty, 0]$, then $\varepsilon_{y,NOT}^{St} = -\varepsilon_S/(\varepsilon_S - \varepsilon_D) \in [-1,0]$.

Note that both of the estimates of $\varepsilon_{y,NOT}^{St}$ from Table 13, - 0.906 from Column 1 and - 0.730 from Column 2, fall inside this interval. The estimated value of $\varepsilon_{y,NOT}^{St}$ = - 0.906 indicates that the supply curve for CEO input is almost ten times as elastic as the supply curve ($\varepsilon_S^{St} = -9.6383\ \varepsilon_D^{St}$). Using $\varepsilon_{y,NOT}^{St}$ = - 0.730 gives $\varepsilon_S^{St} = -2.7037\ \varepsilon_D^{St}$. Restated, the elasticity of demand is about one-tenth (three-eighths) as elastic as the supply curve, with $\varepsilon_D^{St} = -0.1038\ \varepsilon_S^{St}$ ($\varepsilon_D^{St} = -0.3688\ \varepsilon_S^{St}$). Having located the assortative match between the firm and CEO by means of the firm-CEO fixed effect, for both estimates based on large tax shocks the demand curve for CEO input appears to be

highly inelastic relative to the supply curve. The relatively elastic supply curve is consistent with the high responsiveness of CEO pay to state personal income tax shocks. If human capital is relatively mobile relative to the assets of the firm, the supply curve would be relatively more elastic than the demand curve.

7.5. Up Versus Down Elasticity of CEO Compensation in the Net-of-Tax Rate: US State Tax Shocks

Table 13 provides estimates of the relation between changes in both CEO pay and the net-of-tax-rate and that are "well-behaved." By this we mean the estimates $\varepsilon_{y,NOT}^{St}$ = - 0.906 or -0.730 are consistent with a positively sloped supply curve and a negatively sloped demand curve, with $\varepsilon_S \in [0, \infty)$, and $\varepsilon_D \in (-\infty, 0]$, and $\varepsilon_{y,NOT}^{St} = -\varepsilon_S/(\varepsilon_S - \varepsilon_D) \in [-1,0]$. A palatable interpretation is that the supply curve for CEO input, based on the outside options for CEOs on the extensive margin, is almost ten times as elastic as the supply curve (e.g., if $\varepsilon_{y,NOT}^{St}$ = - 0.906 then $\varepsilon_S^{St} = -9.6383\ \varepsilon_D^{St} > 0$). Based on Tables 2 and 9, however, there is motive to adjust this framework to accommodate the possibility of agency issues and rent extraction.

Accordingly, as in the DiD analysis, we allow for asymmetry by estimating upside and downside elasticities, based on increases versus decreases, respectively, in state personal income tax shocks. Table 14 presents results that are decidedly asymmetric. The elasticity of CEO pay in the inverse NOT is insignificant for large decreases in the net-of-tax rate. For large state tax increases, in stark contrast, the CEO pay elasticity in the inverse NOT is large (2.762, $p < 0.001$).

Moreover, any estimate that exceeds 1.0 is inconsistent with conventional supply and demand curves. In particular, in the absence of extracurricular rent extraction in the presence of agency problems, we would expect $-\beta_{-2}^{St} = -\varepsilon_S/(\varepsilon_S - \varepsilon_D) \in [-1,0]$. Rearranging gives $\beta_{-2}^{St}\varepsilon_D = (\beta_{-2}^{St} - 1)\varepsilon_S$. For $\beta_{-2}^{St} > 1,\ \beta_{-2}^{St} - 1 > 0$, the supply and demand curves have the same sign.

This inconsistency accords with the DiD estimates that indicate that CEOs are more than fully compensated for a state income tax increase. The upside departure from the standard supply and demand framework, with $1 < \beta_{-2}^{St} = -\varepsilon_{y,NOT}^{St} = 2.762$, suggests that agency issues and executives with the power and disposition to extract rents are a factor in resetting CEO pay after a state personal income tax increase.

8. Further Considerations

8.1. Data

Several items warrant brief attention. A departing or arriving CEO introduces noise into our empirical analysis. CEOs who move obtain higher pay (e.g., Fee and Hadlock, 2013; Coles et al., 2018) and the former paper reports that the compensation change can be explained in part by the compensation for the equity position forfeited at the prior employer and by the prior employer's performance. Accordingly, we have restricted observations on the change in compensation to include those for which the CEO stays at the same firm for the two years following the relevant change in the personal income tax rate.

Second, about 2.5% of our sample of CEO-year observations have a tax change in two consecutive years. First-differencing removes unobserved firm-specific fixed effects in the corresponding levels equation. Thus, our specification accommodates: repeated treatments (the possibility that a firm experiences a sequence of tax increases or tax cuts over its time in the panel); treatment reversals (a tax increase followed sometime later by a tax cut, or vice versa); manager turnover; and differences in firms' responses to tax changes. See Heider and Ljungqvist (2015).

Third, significant elements of our empirical analysis rely on the idea that changes in TDC1 (Execucomp), as adjusted per Coles, Daniel, and Naveen (2013), reflect pay adjustments that arise

in response to changes in the personal income tax rates that are applied to taxable income. To examine this notion in more detail, note that total compensation includes some or all of annual salary, annual bonus, and long-term cash bonus, as well as the grant date fair value (GDFV) estimates for stock and option awards. While annual salary and bonus are part of taxable income in the year they are paid, the grant date fair values of stock and option grants need not be. Under standard time-based vesting, the receipt of stock and options occurs in the future, with the actual taxable date and taxable value possibly being uncertain at the time of the award.[22] Performance-vesting provisions (Bettis et al., 2010, 2018), under which the number of units of cash, stock, or options ultimately received depends on one or more accounting or market performance metrics, introduce additional uncertainty about actual taxable income.

Of course, in estimating the value of stock and option awards, compensation committees and consultants often apply standard SEC- and FASB-sanctioned methods to capture the range and likelihood of possible outcomes (Bettis et al., 2018). The very act of generating a grant date fair value to disclose requires some understanding of these uncertainties. Thus, GDFV potentially provides a reasonable estimate of the present discounted taxable value of those awards. Furthermore, even if GDFV is biased one way or another relative to the present value of taxable income, if the bias is similar from year to year then there is some hope that using the *change* in GDFV removes that bias, so that $\Delta Ln(y_{m,t}) = Ln(y_{m,t}) - Ln(y_{m,t-1})$ is a reasonable proxy for

[22] A stock award is taxed at the ordinary rate at market value at the time it vests. If the executive holds the stock, then subsequent tax is based on the gain or loss since vesting at either the ordinary income tax rate or the favorable capital gains rate, depending on holding period since vesting. Most options are issued at the money and are taxed at exercise, with the ordinary rate applied to the difference between the market value of the stock acquired net of the exercise price. Again, if the executive continues to hold the stock, then subsequent tax is based on the gain or loss since exercise and either the ordinary income tax rate or the capital gains rate applies, depending on the holding period.

the change in the discounted value of taxable income. This reinforces the use of $\Delta Ln(y_{m,t})$ on the left-hand side of regression specifications.

8.2. Do locational choices attenuate the results?

One possible reason for the high responsiveness of CEO pay to state personal income tax shocks is that CEOs can threaten to quit for another position in a state with a lower top tax rate. If the costs of relocating are low, then such a threat is credible. The large, estimated response in CEO pay to a state income tax shock is consistent with low locational frictions and a credible threat by the CEO of moving to another job in a low-tax state.

Locational considerations, however, potentially have a countervailing effect. Some executives may already be taxed in another state or can move to another state that differs from the firm's domicile and was not treated with an income tax shock but still serve as CEO. Some reciprocal state tax agreements can make this feasible.[23] Such prior locational choice or response would reduce the need for the firm to compensate the CEO for an increase in the state personal income tax rate and would attenuate our parameter estimates of the effect of a tax shock on CEO pay.[24]

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[23] For example, until 2017 Pennsylvania and New Jersey operated under a reciprocity agreement. If a Pennsylvania (New Jersey) resident worked in New Jersey (Pennsylvania), that person was taxed in their state of residence. Pennsylvania's top rate was 3.07% while the top rate in New Jersey was 8.97%. Pennsylvanians (New Jersey residents) who worked in New Jersy (Pennsylvania) paid a top rate of 3.07% (8.97%). All else (such as property taxes) equal, the incentive for a CEO of a Garden State firm to live in the Pennsylvania would have been substantial. States are fully aware of the incentive to shop for low-tax tax domicile and to source employment income in a low-tax state. Not surprisingly, New Jersey abrogated the New Jersey side of the reciprocity agreement, though the Pennsylvania side remains. After nearly forty years, in September 2016 New Jersey Governor Chris Christie terminated the New Jersey agreement with Pennsylvania, effective January 1, 2017. While at the time Governor Christie's office declined to provide an estimate of the gain in tax revenue, a former State Treasurer of New Jersey estimated that ending the agreement could generate an additional $180 million annually for New Jersey. Since then, New Jersey has increased the top personal income tax rate further to 10.97% (2024). See https://www.inquirer.com/philly/news/politics/20160903_Christie__seeking_revenue__ends_40-year_tax_agreement_with_Pa_.html.

[24] On the other hand, some interstate tax agreements are asymmetric. For example, if a CEO worked in Arizona but lived in California, Indiana, Oregon, or Virginia, the CEO could ask for an exemption from Arizona state personal income tax and withholding of that tax. Then a tax increase in Arizona would not affect the CEO. The reverse is not true. If the CEO worked in California but was a resident of Arizona, California did not accord symmetric treatment. The CEO would pay state income tax to California. If the rate in the state of residence were higher than that in

Such locational considerations are unlikely to attenuate significantly our estimates of the sensitivity of executive pay to changes in the personal state income tax rate. First, there are not many relevant state reciprocity agreements. As of the end of 2016, in 17 states including the District of Columbia, nonresident workers who live in reciprocal states did not have to pay state taxes in the work state.[25] And one-way agreements are infrequent. In 2016 there were 64 ordered state pairs with an asymmetric one-way arrangement, which was only 2.51% of the 2,550 possible one-way arrangements among 51 jurisdictions, the 50 states and Washington, DC. Moreover, states have erected additional barriers to the locational approach to avoiding state income tax.[26]

Second, Duchin and Sosyura (2021) examine how remote management by CEOs affects their financial decisions and ability to create shareholder value. They define a "long-distance CEO" as one who commutes at least 50 miles each way to corporate headquarters and does not own a residence within 50 miles of headquarters. Because some corporate headquarters are farther than 50 miles from the nearest bordering state, such long-distance CEOs are likely to live in their work state. Thus, the set of long-distance CEOs should contain almost all CEOs who would be insulated from a state personal income tax increase in their work state, as well as other commuting CEOs who still would be subject to a state tax change. Duchin and Sosyura (2021) find 1,925 long-distance CEO-firm-years among US domiciled firms listed in the US over the period 2000 – 2020.

California, the tax paid to California would be credited towards the tax due in the state of residence and the CEO would pay any shortfall to the state of residence. In cases such as this, the effective top income tax rate is the higher of the two state tax rates.

[25] See https://www.thebalance.com/state-with-reciprocal-agreements-3193329.

[26] We have in mind, for example, New York's "convenience of the employer" rule. New York is one of several states with a statute that specifies whether an employee working from a home office outside of the state is liable for nonresident income tax. (See https://taxnews.ey.com/news/2020-2543-new-york-issues-guidance-on-the-nonresident-income-tax-liability-to-employees-working-temporarily-outside-of-the-state-due-to-covid-19.) Under this test, nonresident income tax applies if the employee is working outside of the state for the employee's own convenience rather than the necessity of the employer and the employee spends at least one day in New York in the calendar year. Conversely, if the remote work arises from the convenience or necessity of the employer, nonresident NY income tax does not apply.

Over that period there were 105,819 US-firm-year US listings, so the percentage of firm years with a commuter CEO is 1.82%. We view this small percentage as an upper bound on the proportion of CEOs who preemptively avoid a state tax increase in their work state.[27]

Third, as did Duchin and Sosyura (2021), we obtain the CEO residential address data used by Bernile, Bhagwat, and Yonker (2018).[28] In our sample, we find that in 99.3% of CEO-year cases the CEO owns a residence located in the same state as the corporate headquarters. While it is possible that some of these CEOs reside in another abode in a different state, almost all CEOs have the option to make their work state their tax domicile as well.

In summary, it appears that our coefficient estimates on the effect of state personal income tax changes on CEO pay are unlikely to be attenuated by the presence in the sample of a significant number of CEOs avoiding taxes by way of prior locational choices.

8.3. Other taxes

States, counties, and municipalities raise funds by various means, including personal income and property taxes. Texas, for example, offers a package of zero state personal income taxes but high property taxes. Hawaii, on the other hand, has low property taxes but high income taxes.

To assess whether the substitution between property and income taxes contaminates our results, we redo all tests while excluding all states with no personal income tax. The parameter estimates and conclusions are not materially different.

9. Conclusion

[27] Moreover, as Duchin and Sosyura (2021) document, the costs to shareholders of a long-distance CEO include lower operating performance and, in some instances, material commuting costs (as disclosed in the DEF14A). Such costs and poor performance likely contribute to the low incidence of long-distance CEOs. Firms are likely to resist.

[28] We thank Scott Yonker for sharing their data on executives' home addresses.

Depending on the empirical design, the firm pays nearly all or more than all of any increase in the CEO's state personal income taxes. First, based on estimates from a DiD model, two years after a large increase in the personal state income tax rate, the CEO receives significantly higher pay, primarily in the form of long-term cash bonuses and awards of stock in the firm, that more than offsets the tax increase. Specifically, CEOs receive an increase in pay of about 6.4% to 7.4% following large state personal income tax increases, relative to CEOs who do not experience such tax shocks, controlling for various other determinants of compensation. In comparison, the pay increase that, on average, would make the CEO whole after the state personal income tax shock would be 3.46%. The size of the pay increase depends positively on the viability of outside employment options for the CEO. The pay increase is larger when the firm has higher margins and higher Tobin's Q and when corporate governance, measured by board independence and the E-index, is weak.

In stark contrast, in the DiD setup we find that income tax rate decreases have minimal effects on CEO pay. The effects on CEO pay of tax increases and decreases are decidedly asymmetric. The lack of a downside response in pay to a tax increase, controlling for other determinants of pay, suggests that CEOs are entrenched at least to some extent and possess and exercise the ability to extract rents other than by means of credible outside employment options.

Second, we implement the elasticity framework commonly employed in prior literature (e.g., Frydman and Malloy, 2011). Our estimates of the elasticity of abnormal CEO pay in the inverse of the net-of-tax rate, with symmetry imposed on increases and decreases, indicate that a 1% decrease (increase) in the CEO's inverse net-of-tax rate for large tax changes is associated with as much as a 0.730% - 0.906% increase (decrease) in total compensation two years later, as compared to the 1% increase that would fully compensate the CEO for the tax increase. These estimates are

consistent with a demand curve for CEO input that is highly inelastic compared to the supply curve. The extensive margin for CEO input, based on outside employment options in domiciles with lower state tax rates, appears to confer significant market power on CEOs.

If instead we do not impose symmetry, the elasticity estimate in the inverse NOT for state income tax increases becomes quite large. A 1% increase in the CEO's net-of-tax rate for large tax changes is associated with as much as a 2.762% increase in total compensation two years later, far more than the 1% that would be required to fully compensate the CEO for the state income tax shock. Furthermore, the downside elasticity based on decreases in state income tax rates is economically and statistically insignificant. Both of these results indicate that there are agency problems, governance is imperfect, and that CEOs possess and apply influence and power in the pay setting process.

Edmans, Gabaix and Jenter (2017) list three perspectives as being particularly useful to understand managerial compensation: market forces and shareholder value maximization; executive bargaining power and rent extraction; and institutional forces, such as taxes. Our results reflect and inform all three of those perspectives. The combination of the strong effect of personal income taxes on pay, the magnitude of the elasticity of executive pay in the net-of-tax rate, the asymmetry in the effect of tax increases versus decreases, and the effects of taxes on the incentive properties arising from the various components of executive compensation quantify the degree to which labor market forces, on the one hand, and agency problems, governance, and rent seeking, on the other, shape the way that CEO pay responds to personal income tax rates.

A question we are unable to address without more data is the incidence at the firm level of the changes in CEO pay. To know the extent to which the cost to the firm is spread across

shareholders, bondholders, other labor, other factors of production, customers, or suppliers requires data we do not possess.

Our analysis has implications for policy. For example, there are recent calls at the state and federal level to increase income tax rates on high earners, such as CEOs and other NEOs. Our results highlight the fact that whether changing income tax rates would reduce the inequalities in earnings between top executives and the median or rank-and-file worker depends on the elasticity of firm demand for each type of employee.[29]

[29] Supposing that a state uses a flat rate for the personal income tax, if the demand curve for CEO and other NEO input is more inelastic than the demand curve for rank-and-file employees, an increase in the flat state income tax rate likely will increase earnings inequality in the firm. Such factors also will determine the success of various other initiatives, including California Senate Bill 37, which would impose significant taxes on firms that have the largest gaps between the highest-earning and lowest-paid employees. California SB 37, the "Corporate Fair Share for California and Californians," originally proposed that large corporations that do business in California would face a tax increase of 2% to 6%, depending on the difference between what the CEO is paid and the pay of their average worker (https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201920200SB37). As of January 2020, an amended version of the bill, applying only to companies with earnings more than $10 million, would tax companies based on the gap between the highest and lowest paid employees. California corporations would face a tax increase from 10.84% to as much as 14.84%, while California-domiciled financial institutions are looking at a possible increase from 12.82% to 16.84%. Read more in the *Sacramento Bee*, January 17, 2020 (https://www.sacbee.com/opinion/california-forum/article239287588.html#storylink=cpy) and the *California Globe*, February 24, 2020 (https://californiaglobe.com/section-2/california-businesses-could-face-higher-taxes-based-on-gap-between-highest-and-lowest-wages/).

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Figure 1. Large State Personal Income Tax Rate Shocks Over Time

This figure shows the yearly number of large increases and decreases in state-level personal income tax rates between 1992 and 2022, where the large changes are those exceeding one percentage point for earners in the top tax bracket. The blue (orange) bars are for increases (decreases) in tax rates.

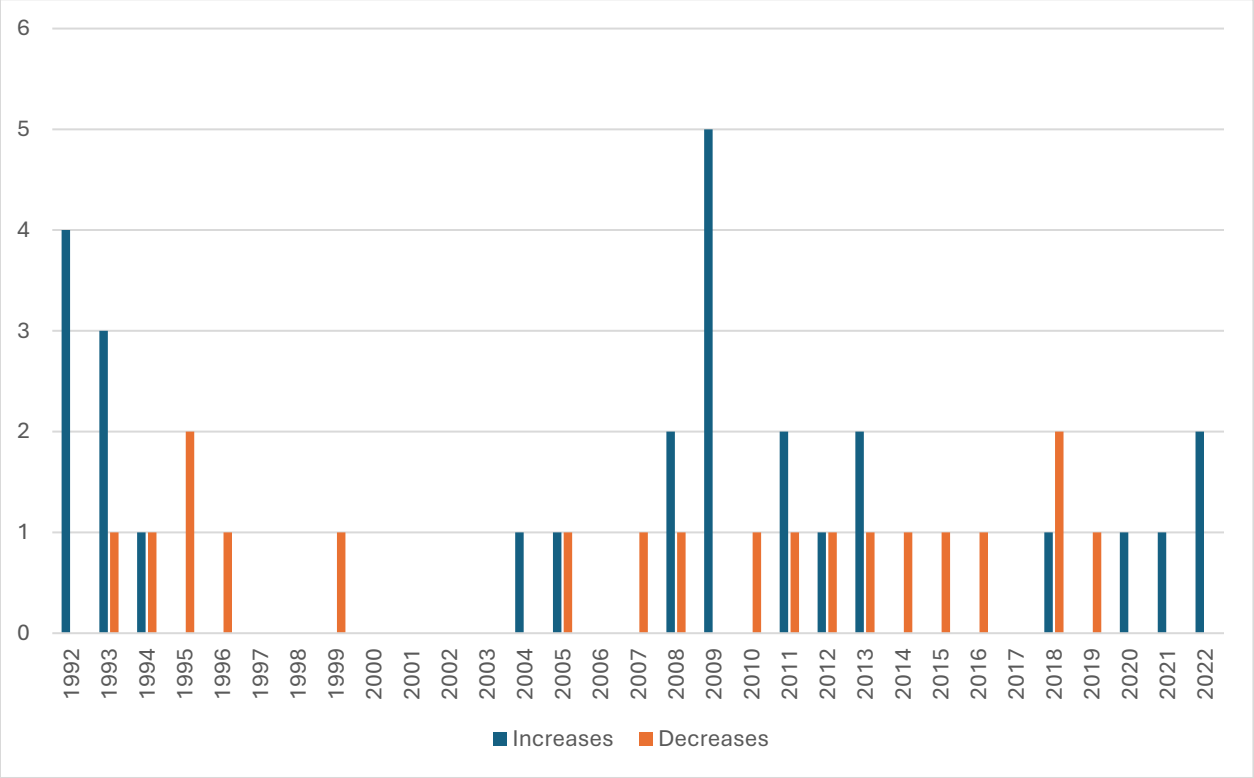
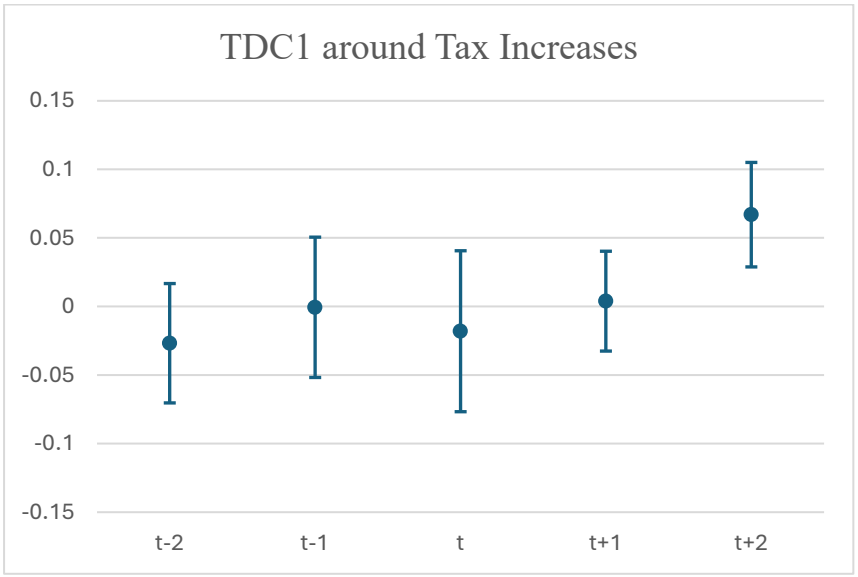


Figure 2. Differences in CEO Pay Changes Between Treated and Control Groups in Years Around Tax Changes

This figure shows the differences in CEO pay changes between the treated group and control group around tax changes. The treated group includes CEOs in firms headquartered in states experiencing large personal income tax rate changes (greater than one percentage point). The control group includes CEOs in firms headquartered in states without personal income tax changes. Panel A (B) is for tax increases (decreases). The x-axis shows the year relative to an event year (as year t). The y-axis shows the difference in CEO pay changes [Δln(TDC1), to be used as the dependent variable in DiD analysis]. The blue dots represent the average yearly differences in Δln(TDC1) between treated and control groups. The bars show the 90% confidence intervals.

Panel A. Tax increases



Panel B. Tax decreases

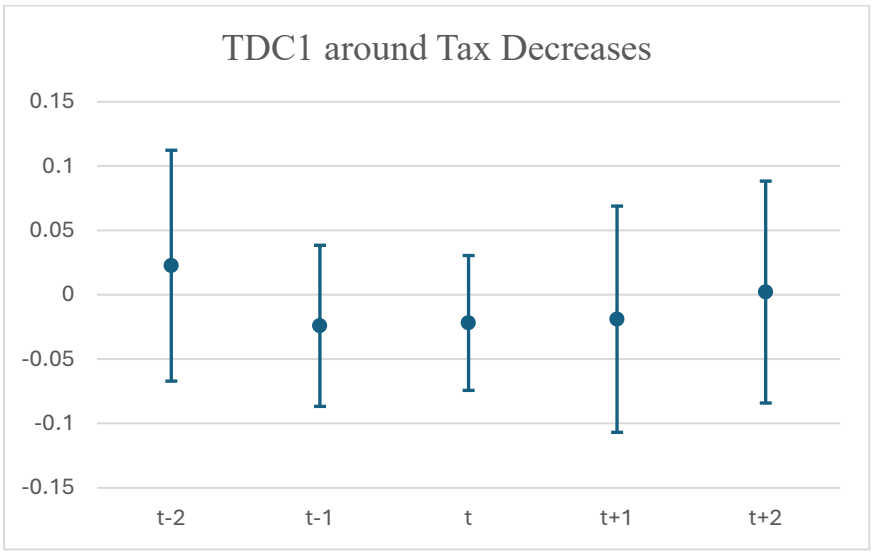


Figure 3. Components of CEO Compensation

This figure illustrates the yearly average of the value of the components of CEO compensation between 1992 and 2022 inclusive. The components include salary, bonus, non-equity incentives, stock, and options in thousands of US$. The data are from Execucomp.

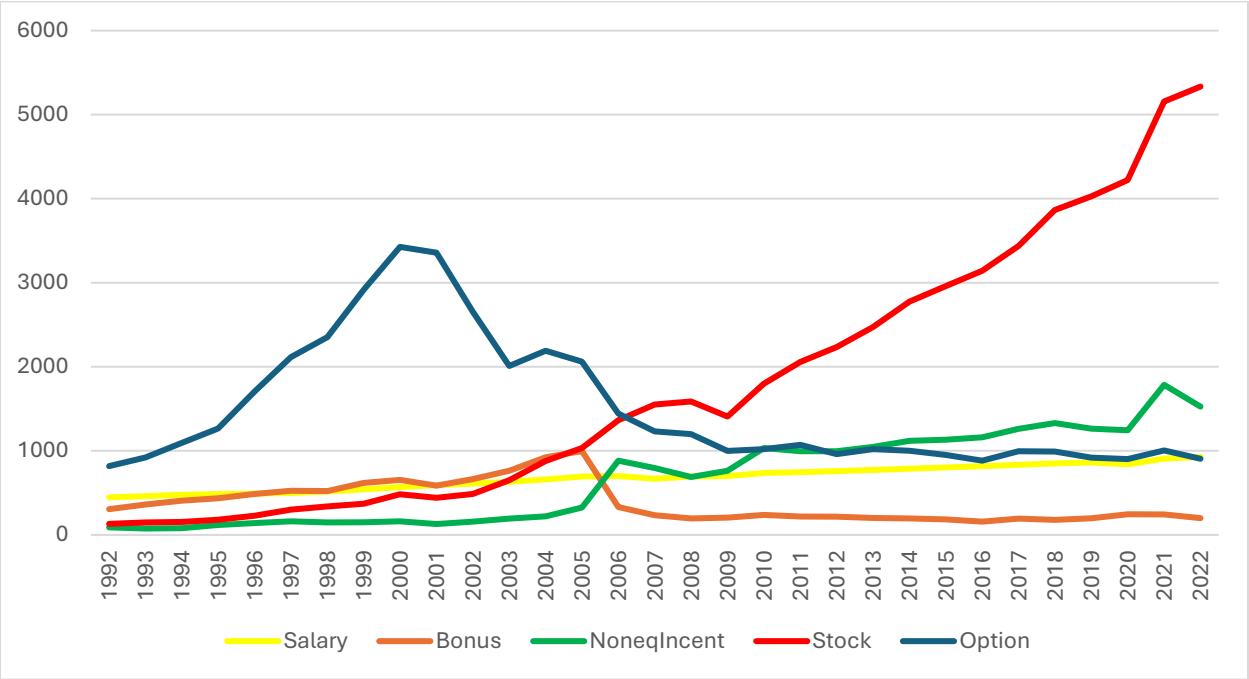


Figure 4. Examples for Neighbor States Without Tax Shocks

This figure shows examples for neighboring control states for treated states with tax increases or increases. For example, North Dakota (ND) had a tax increase [in Red]; Montana (MT) and South Dakota (SD) are neighbors without shocks [in Yellow]; Minnesota (MN) had a tax increase, so is not designated as a neighbor control state. In our sample, in total we have 15 (14) unique states with large tax increases (decreases) and correspondingly have 20 (21) unique neighboring control states without tax shocks.

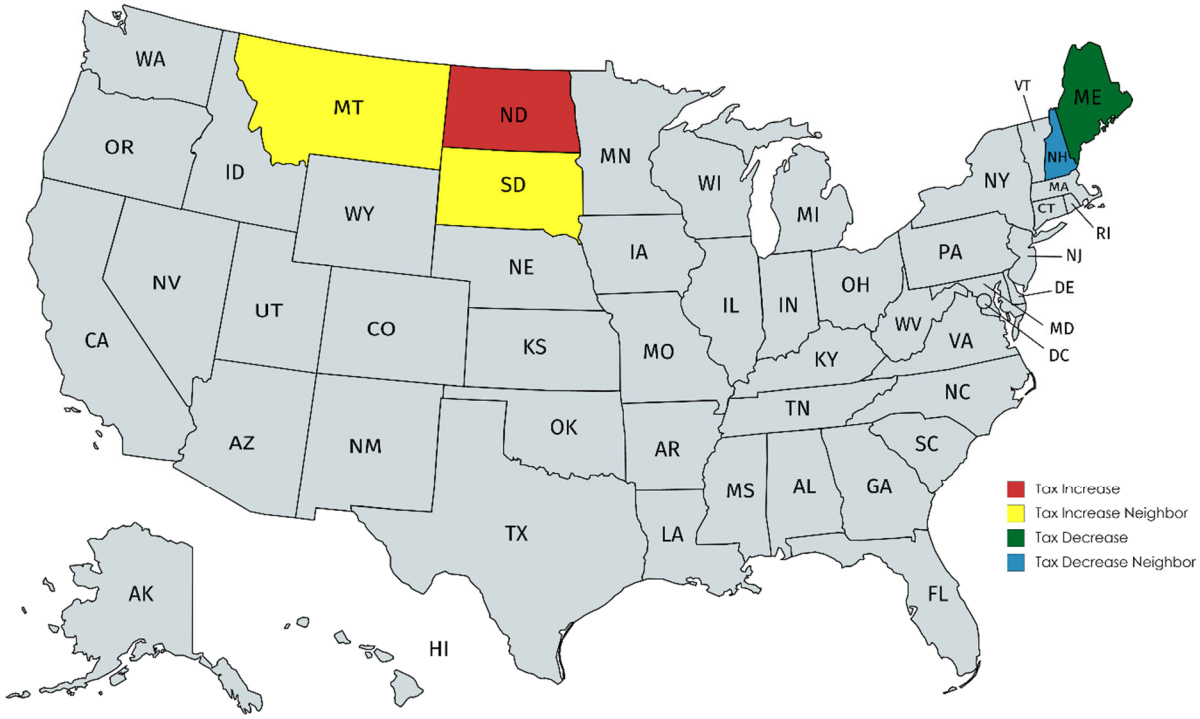


Table 1. Summary Statistics

This table presents summary statistics for US data for state tax shocks (Panels A and B) and international data on federal tax shocks (Panel C). Panel A displays changes in the top state personal income tax rate. Panel B provides summary statistics for the US at the level of CEO-firm-year on compensation, personal income tax rate changes and firm characteristics. The US sample consists of firms in the intersection of Execucomp and Compustat for the years 1992 – 2022 inclusive. The compensation-related variables are in thousands of US dollars. Assets are in millions of dollars. The international data sample is based on federal tax shocks for 21 countries (including US) for the years 2011– 2022 (Panel C). Variables (except dummy variables) are winsorized at the 1st and 99th percentile values. Variable definitions are in Appendix 1.

Panel A: Top State and US Federal Personal Income Tax Rate Changes

	US STATE Mean | Count		
	Mean Increase	Mean Decrease	Both
Large	1.95% | 27	-1.60% | 19	NA | 46
Small	0.22% | 89	-0.22% | 236	NA | 325
Total	0.62% | 116	-0.32% | 255	NA | 371

	US FEDERAL Mean | Count		
	Mean Increase	Mean Decrease	Both
Large	6.60% | 2	-3.10% | 2	NA | 4
Small	NA	-0.50% | 2	NA | 2
Total	6.60% | 2	-1.80% | 4	NA | 6

Panel B: CEO-Firm-Year Summary Statistics, US Sample

Variable	Mean	SD	p25	p50	p75	N
CEO-Firm-Year						
Large State Tax Increase (0, 1)	0.026	0.160	0	0	0	22,291
Large State Tax Decrease (0, 1)	0.013	0.114	0	0	0	22,291
Small State Tax Increase (0, 1)	0.051	0.219	0	0	0	22,291
Small State Tax Decrease (0, 1)	0.135	0.342	0	0	0	22,291
Total Pay (TDC1) ($1,000s)	5,879	6,070	1,836	3,925	7,611	22,291
Salary ($1,000s)	769	357	501	725	990	22,291
Bonus ($1,000s)	335	732	0	0	374	22,291
Noneq Incentives ($1,000s)	837	1,363	0	198	1,162	22,291
Stock Pay ($1,000s)	1,971	3,155	0	558	2,673	22,291
Option Pay ($1,000s)	1,609	3,004	0	540	1,838	22,291
Perquisites ($1,000s)	237	665	13	52	180	22,291
Firm-Year						
Assets ($1,000,000s)	6,489	19,635	552	1,477	4,531	22,291
MTB	2.189	1.468	1.279	1.711	2.536	22,291
ROA	0.047	0.104	0.021	0.057	0.095	22,291

Panel C: CEO-Firm-Year Summary Statistics, International Sample

Variable	Mean	SD	p25	p50	p75	N
CEO-Firm-Year						
Large National Tax Increase (0, 1)	0.080	0.271	0	0	0	6,884
Large National Tax Decrease (0, 1)	0.077	0.267	0	0	0	6,884
Total Pay (TDC1) ($1,000s)	5,953	3,919	2,874	5,185	8,373	6,884
Salary ($1,000s)	878	368	630	862	1,056	6,883
Bonus ($1,000s)	98	395	0	0	0	6,368
Noneq Incentives ($1,000s)	1,152	1,248	235	840	1,657	6,360
Stock Pay ($1,000s)	2,831	2,742	687	2,035	4,218	6,360
Option Pay ($1,000s)	788	1,313	0	0	1179	6,360
Perquisites ($1,000s)	227	610	18	61	186	6,360
Firm-Year						
Assets ($1,000,000s)	9,807	29,152	824	2335	7,353	6,884
MTB	2.144	1.515	1.242	1.657	2.454	6,884
ROA	0.045	0.098	0.017	0.051	0.088	6,884

Table 2. CEO Compensation Responsiveness to State Personal Income Tax Changes (DiD)

This table shows the effects of changes in personal US state income tax rates on CEO compensation. *Tax Increase* (*Decrease*) is a dummy variable that equals one if a CEO's state personal income tax rate increases (decreases) by at least one percentage point in a year and zero otherwise. Total pay is TDC1 in Execucomp database. The dependent variable is Δln(TDC1) and the control variables are transformed Assets, MTB, and ROA, Δ denotes difference, and Ln(.) is the natural logarithm. All specifications include CEO-Firm and Industry-Year fixed effects. Robust standard errors are clustered at the state level. Variables are defined in Appendix 1. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

	Base Control Sample			Spotless Control Sample		
	(1)	(2)	(3)	(4)	(5)	(6)
Dep. Variable	ΔLn(TDC1)			ΔLn(TDC1)		
Tax Increase$_{t-1}$	0.008		0.008	0.013		0.012
	[0.41]		[0.41]	[0.61]		[0.60]
Tax Increase$_{t-2}$	0.064***		0.066***	0.072***		0.074***
	[3.75]		[3.89]	[4.76]		[5.13]
Tax Decrease$_{t-1}$		-0.011	-0.014		-0.013	-0.016
		[-0.32]	[-0.43]		[-0.28]	[-0.37]
Tax Decrease$_{t-2}$		0.016	0.021		0.013	0.020
		[0.44]	[0.58]		[0.31]	[0.47]
ΔLn(Assets)	0.328***	0.327***	0.328***	0.336***	0.335***	0.336***
	[12.35]	[12.34]	[12.29]	[10.63]	[10.55]	[10.54]
ΔMTB	0.074***	0.074***	0.074***	0.072***	0.072***	0.072***
	[9.61]	[9.55]	[9.59]	[8.58]	[8.52]	[8.53]
ΔROA	0.392***	0.394***	0.392***	0.303***	0.304***	0.303***
	[5.88]	[5.88]	[5.89]	[5.37]	[5.38]	[5.39]
Observations	22,291	22,291	22,291	15,563	15,563	15,563
R-squared	0.196	0.196	0.196	0.212	0.212	0.212
CEO-Firm FE	Y	Y	Y	Y	Y	Y
Industry-Year FE	Y	Y	Y	Y	Y	Y

Table 3. CEO Compensation Components and Large State Personal Income Tax Changes

This table shows the effects of changes in US state personal income tax rates on the components of CEO compensation. *Tax Increase* (*Decrease*) is a dummy variable that equals one if a CEO's state personal income tax rate increases (decreases) by at least one percentage point in a year and zero otherwise. The dependent variable is the change in the logarithm of the component of CEO compensation. The control variables are transformed Assets, MTB, and ROA, where Δ denotes difference, and Ln(.) is the natural logarithm. All specifications include CEO-Firm and Industry-Year fixed effects. Robust standard errors are clustered at the state level. Variables are defined in Appendix 1. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Base Control Sample

	(1)	(2)	(3)	(4)	(5)
VARIABLES	ΔLn(Salary)	ΔLn(Bonus)	ΔLn(NonEqIncent)	ΔLn(Stock)	ΔLn(Option)
Tax Increase$_{t-1}$	-0.008	-0.064	0.017	-0.035	-0.049
	[-0.71]	[-0.63]	[0.40]	[-0.74]	[-1.37]
Tax Increase$_{t-2}$	-0.012	0.014	0.109***	0.066**	0.008
	[-0.76]	[0.20]	[2.88]	[2.35]	[0.20]
ΔLn(Assets)	0.027*	0.360***	0.315***	0.182***	0.386***
	[2.00]	[6.16]	[6.75]	[5.06]	[8.57]
ΔMTB	0.002	0.135***	0.179***	0.028	0.045***
	[1.33]	[8.16]	[6.35]	[1.59]	[4.32]
ΔROA	0.073***	1.445***	1.060***	0.173	0.175***
	[3.07]	[7.51]	[7.45]	[1.56]	[2.86]
Observations	22,201	7,473	9,745	11,469	12,453
R-squared	0.315	0.343	0.303	0.247	0.279
CEO-Firm FE	Y	Y	Y	Y	Y
Industry-Year FE	Y	Y	Y	Y	Y

Panel B: Spotless Control Sample

	(1)	(2)	(3)	(4)	(5)
VARIABLES	ΔLn(Salary)	ΔLn(Bonus)	ΔLn(NonEqIncent)	ΔLn(Stock)	ΔLn(Option)
Tax Increase$_{t-1}$	-0.009	-0.147	0.013	-0.015	-0.067*
	[-0.75]	[-1.46]	[0.32]	[-0.34]	[-1.78]
Tax Increase$_{t-2}$	-0.012	-0.029	0.122***	0.060**	0.033
	[-0.70]	[-0.54]	[3.76]	[2.18]	[0.98]
ΔLn(Assets)	0.016	0.311***	0.326***	0.207***	0.408***
	[1.00]	[3.41]	[6.30]	[4.38]	[8.83]
ΔMTB	0.001	0.138***	0.168***	0.035	0.037***
	[0.87]	[7.43]	[5.91]	[1.57]	[3.16]
ΔROA	0.087***	1.442***	0.831***	0.218	0.131**
	[2.94]	[6.35]	[6.66]	[1.69]	[2.33]
Observations	15,477	5,123	6,690	7,796	8,803
R-squared	0.320	0.373	0.305	0.264	0.291
CEO-Firm FE	Y	Y	Y	Y	Y
Industry-Year FE	Y	Y	Y	Y	Y

Table 4. Do CEO Pay Changes Precede State Personal Income Tax Rate Changes

This table shows the relationship between US state personal income tax rate changes and prior CEO pay changes. Tax Increase (Decrease) is a dummy variable, which equals one if a state experiences an increase (decrease) in personal income tax rate greater than one percentage point in a year and zero otherwise. The CEO pay growth (ΔCEO pay) is the average change in firm-level CEO pay within a state-year. The test sample is at the state-year level. We use the linear probability model. State-level controls include transformed debt, state GDP, tax revenues, cash savings, population, democrat government indicator, and unemployment rate. Δ denotes the first difference. All specifications include state fixed effects and year fixed effects. State financial data is from the Urban Institute. The sample period is 1997 to 2021. Robust standard errors are clustered at the state level. Appendix 1 provides variable definitions. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)
VARIABLES	Tax Increase	Tax Decrease
ΔCEO pay$_{t-1}$	0.024	-0.019
	[1.36]	[-1.17]
ΔCEO pay$_{t-2}$	-0.008	-0.031
	[-0.73]	[-1.63]
ΔLn(State GDP)	0.188	-0.096
	[1.22]	[-0.83]
ΔLn(Population)	0.003	-0.201
	[0.01]	[-0.58]
ΔDemocrat Gov	0.014	-0.028*
	[1.03]	[-1.71]
ΔUnemployment	0.003	-0.050
	[0.10]	[-1.38]
ΔLn(SDebt)	0.025	0.056
	[0.52]	[1.31]
ΔLn(Tax Revenue)	-0.088	0.015
	[-1.64]	[0.77]
ΔLn(SCash)	-0.031	0.022
	[-1.36]	[0.77]
Observations	1,129	1,129
R-squared	0.114	0.066
State FE	Y	Y
Year FE	Y	Y

Table 5. CEO Pay and State Tax Shocks: A Narrative Approach

This table shows the effects of changes in personal income tax rates on CEO compensation. We define exogenous state tax shocks following the narrative approach by Romer and Romer (2010) and Giroud and Rauh (2019), and only these shocks are included in the test sample. Specifically, 38 (out of 46) large tax changes in our sample are identified as exogenous tax changes. *Tax Increase* (*Decrease*) is a dummy variable that equals one if a CEO's state personal income tax rate increases (decreases) by at least one percentage point in a year and zero otherwise. Total pay is TDC1 in Execucomp database. The dependent variable is Δln(TDC1) or a transformed component of CEO compensation, the control variables are transformed Assets, MTB, and ROA, Δ denotes difference, and Ln(.) is the natural logarithm. All specifications include CEO-Firm and Industry-Year fixed effects. Robust standard errors are clustered at the state level. Variables are defined in Appendix 1. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

	Base Control Sample			Spotless Control Sample		
	(1)	(2)	(3)	(4)	(5)	(6)
Dep. Variable	ΔLn(TDC1)			ΔLn(TDC1)		
Tax Increase$_{t-1}$	0.012		0.012	0.017		0.016
	[0.72]		[0.71]	[0.84]		[0.80]
Tax Increase$_{t-2}$	0.068***		0.069***	0.081***		0.083***
	[3.94]		[4.15]	[5.21]		[5.80]
Tax Decrease$_{t-1}$		-0.006	-0.008		-0.012	-0.014
		[-0.16]	[-0.24]		[-0.25]	[-0.32]
Tax Decrease$_{t-2}$		0.018	0.024		0.016	0.025
		[0.48]	[0.65]		[0.38]	[0.58]
ΔLn(Assets)	0.325***	0.327***	0.326***	0.333***	0.335***	0.333***
	[12.29]	[12.37]	[12.27]	[10.48]	[10.55]	[10.39]
ΔMTB	0.074***	0.074***	0.074***	0.072***	0.072***	0.072***
	[9.63]	[9.52]	[9.58]	[8.63]	[8.52]	[8.58]
ΔROA	0.393***	0.394***	0.394***	0.304***	0.304***	0.304***
	[5.92]	[5.87]	[5.92]	[5.49]	[5.36]	[5.48]
Observations	22,228	22,275	22,212	15,498	15,558	15,493
R-squared	0.196	0.196	0.196	0.212	0.212	0.212
CEO-Firm FE	Y	Y	Y	Y	Y	Y
Industry-Year FE	Y	Y	Y	Y	Y	Y

Table 6. CEO Pay and State Tax Shocks: Neighboring Control States

This table shows the effects of changes in US state personal income tax rates on CEO compensation using neighboring control states. *Tax Increase* (*Decrease*) is a dummy variable that equals one if a CEO's state personal income tax rate increases (decreases) by at least one percentage point in a year and zero otherwise. The left (right) panel reports the results using the base (spotless) control sample. Column 1 (4) includes tax-increase treated states and neighboring control states (that have never had a tax rate change). Column 2 (5) includes tax-decrease treated states and neighboring control states (that have never had a tax rate change). Column 3 (6) includes tax-increase treated states, tax-decrease treated states and neighboring control states to both tax-increase and tax-decrease states (that have never had a tax rate change). Total pay is TDC1 in Execucomp database. The dependent variable is Δln(TDC1). The control variables are transformed Assets, MTB, and ROA, Δ denotes difference, and Ln(.) is the natural logarithm. All specifications include CEO-Firm and Industry-Year fixed effects. Robust standard errors are clustered at the state level. Variables are defined in Appendix 1. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

	Base Control Sample			Spotless Control Sample		
	(1)	(2)	(3)	(4)	(5)	(6)
Dep. Variable	ΔLn(TDC1)			ΔLn(TDC1)		
Tax Increase$_{t-1}$	0.006		0.004	0.009		0.008
	[0.31]		[0.20]	[0.44]		[0.40]
Tax Increase$_{t-2}$	0.069***		0.064***	0.072***		0.073***
	[4.26]		[3.91]	[5.15]		[5.34]
Tax Decrease$_{t-1}$		-0.006	-0.008		-0.011	-0.014
		[-0.17]	[-0.26]		[-0.24]	[-0.33]
Tax Decrease$_{t-2}$		0.009	0.016		0.006	0.013
		[0.26]	[0.47]		[0.16]	[0.34]
ΔLn(Assets)	0.306***	0.317***	0.315***	0.320***	0.320***	0.321***
	[10.41]	[12.22]	[11.80]	[9.84]	[9.82]	[9.83]
ΔMTB	0.072***	0.073***	0.073***	0.071***	0.071***	0.071***
	[8.35]	[9.05]	[9.18]	[8.29]	[8.28]	[8.29]
ΔROA	0.316***	0.353***	0.355***	0.291***	0.293***	0.292***
	[5.85]	[5.81]	[5.87]	[4.97]	[4.99]	[4.99]
Observations	17,827	20,403	20,598	14,696	14,735	14,735
R-squared	0.207	0.202	0.201	0.215	0.215	0.215
CEO-Firm FE	Y	Y	Y	Y	Y	Y
Industry-Year FE	Y	Y	Y	Y	Y	Y

Table 7. Distance to State Border, Tax Increases, and CEO Compensation

This table shows the effects of changes in personal income tax rates on CEO total compensation. *Tax Increase* is a dummy variable that equals one if a CEO's state personal income tax rate increases by at least one percentage point in a year and zero otherwise. *Miles to nearest state border* is the number of miles from a firm's address to its nearest neighbor state border. Total pay is TDC1 in Execucomp. The dependent variable is Δln(TDC1). The control variables are transformed Assets, MTB, and ROA, Δ denotes difference, and Ln(.) is the natural logarithm. All specifications include CEO-Firm and Industry-Year fixed effects. Robust standard errors are clustered at the state level. Variables are defined in Appendix 1. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

	(1) Base Control Sample	(2) Spotless Control Sample
Dep. Variable	ΔLn(TDC1)	ΔLn(TDC1)
Tax Increase$_{t-1}$	0.013	0.022
	[0.65]	[0.96]
Tax Increase$_{t-2}$	0.062**	0.068**
	[2.00]	[2.31]
Tax Increase$_{t-2}$ × Miles to nearest border state	0.000	0.000
	[0.16]	[0.31]
ΔLn(Assets)	0.322***	0.329***
	[12.71]	[11.04]
ΔMTB	0.072***	0.069***
	[7.45]	[6.42]
ΔROA	0.370***	0.282***
	[5.35]	[4.83]
Observations	20,776	14,519
R-squared	0.198	0.214
CEO-Firm FE	Y	Y
Industry-Year FE	Y	Y

Table 8. Relative Bargaining Power and CEO Compensation

This table shows the role of locational considerations, profitability, and MTB in the effects of tax increases on CEO compensation. Columns 1 and 2 are for tests of the viability of the CEOs outside options. For column 3 the sample is split into high-profit and low-profit groups based on the within-industry median of profit margin, where the profit margin of a firm is defined as (Sale – COGS)/Sale and industry is classified at the two-digit SIC level. Column 4 uses MTB as a measure of the value of the CEO in managing the assets. *Tax Increase* is a dummy variable that equals one if a CEO's state personal income tax rate increases by at least one percentage point in a year and zero otherwise. The dependent variable is Δln(TDC1). The control variables are transformed Assets, MTB, and ROA, Δ denotes difference, and Ln(.) is the natural logarithm. All specifications include CEO-Firm fixed effects and Industry-Year fixed effects. Robust standard errors are clustered at the state level. Variables are defined in the Appendix. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

VARIABLES	(1)	(2)	(3)	(4)
	ΔLn(TDC1)			
	Non-Founder	# Firms in Industry	Profit Margin	MTB
Tax Increase$_{t-2}$	-0.056	0.017	0.028	0.017
	[-1.49]	[0.62]	[0.90]	[0.47]
Tax Increase$_{t-2}$ x Non Founder	0.146***			
	[3.70]			
Tax Increase$_{t-2}$ x High # Firms in Ind		0.089**		
		[2.49]		
Tax Increase$_{t-2}$ x High Margin			0.070*	
			[1.69]	
Tax Increase$_{t-2}$ x High MTB				0.088*
				[1.90]
ΔLn(Assets)	0.337***	0.327***	0.328***	0.323***
	[12.25]	[12.51]	[12.42]	[12.50]
ΔMTB	0.073***	0.073***	0.074***	0.071***
	[9.35]	[9.49]	[9.62]	[8.61]
ΔROA	0.386***	0.373***	0.393***	0.385***
	[5.68]	[5.66]	[5.89]	[5.60]
Observations	21,708	22,291	22,291	22,291
R-squared	0.198	0.197	0.196	0.197
CEO-Firm FE	Y	Y	Y	Y
Industry-Year FE	Y	Y	Y	Y

Table 9. Agency/Governance Concerns and CEO Compensation

This table shows the role of governance in the effects of tax increases on CEO compensation. Columns 1 and 2 use the entrenchment index and board independence as indicators of governance. *Tax Increase* is a dummy variable that equals one if a CEO's state personal income tax rate increases by at least one percentage point in a year and zero otherwise. The dependent variable is Δln(TDC1). The control variables are transformed Assets, MTB, and ROA, Δ denotes difference, and Ln(.) is the natural logarithm. All specifications include CEO-Firm fixed effects and Industry-Year fixed effects. Robust standard errors are clustered at the state level. Variables are defined in the Appendix. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

VARIABLES	(1)	(2)
	ΔLn(TDC1)	
	E Index	Board Independence
Tax Increase$_{t-2}$	-0.018	0.016
	[-0.97]	[0.59]
Tax Increase$_{t-2}$ x High E Index	0.108***	
	[3.02]	
Tax Increase$_{t-2}$ x Low BoD Indep		0.067**
		[1.97]
ΔLn(Assets)	0.309***	0.288***
	[10.02]	[7.28]
ΔMTB	0.072***	0.075***
	[8.71]	[8.01]
ΔROA	0.463***	0.471***
	[6.30]	[7.57]
Observations	16,665	15,226
R-squared	0.210	0.216
CEO-Firm FE	Y	Y
Industry-Year FE	Y	Y

Table 10. NEO (Non-CEO) Compensation Responsiveness to Personal Income Tax Changes

This table shows the effects of changes in US state personal income tax rates on non-CEO named executive officer (NEO) total compensation. *Tax Increase* (*Decrease*) is a dummy variable that equals one if a NEO's state personal income tax rate increases (decreases) by at least one percentage point in a year and zero otherwise. Total pay is TDC1 in Execucomp. The dependent variable is Δln(TDC1), the control variables are transformations of Assets, MTB, and ROA, Δ denotes difference, and Ln(.) is the natural logarithm. All specifications include NEO-Firm and Industry-Year fixed effects. Robust standard errors are clustered at the state level. Variables are defined in Appendix 1. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)
VARIABLES		ΔLn(TDC1)	
Tax Increase$_{t-1}$	-0.023		-0.022
	[-1.16]		[-1.07]
Tax Increase$_{t-2}$	0.024		0.025*
	[1.52]		[1.73]
Tax Decrease$_{t-1}$		0.003	-0.001
		[0.08]	[-0.03]
Tax Decrease$_{t-2}$		0.032	0.032
		[0.67]	[0.69]
ΔLn(Assets)	0.250***	0.250***	0.250***
	[11.51]	[11.40]	[11.38]
ΔMTB	0.063***	0.063***	0.063***
	[8.69]	[8.73]	[8.72]
ΔROA	0.335***	0.336***	0.335***
	[3.79]	[3.81]	[3.79]
Observations	75,934	75,934	75,934
R-squared	0.212	0.212	0.212
NEO-Firm FE	Y	Y	Y
Industry-Year FE	Y	Y	Y

Table 11. CEO Compensation and *International* National Personal Income Tax Changes: DiD Analysis

This table shows the effects of changes in national personal income tax rates on CEO compensation. *Tax Increase* (*Decrease*) is a dummy variable that equals one if a CEO's national personal income tax rate increases (decreases) by at least one percentage point in a year and zero otherwise. The dependent variable is ΔLn(TDC1) or a transformed component of CEO compensation, the control variables are transformed Assets, MTB, and ROA, Δ denotes difference, and Ln(.) is the natural logarithm. All specifications include CEO-Firm and Industry-Year fixed effects. Robust standard errors are clustered at the state level. Variables are defined in Appendix 1. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)
VARIABLES		ΔLn(TDC1)	
Tax Increase$_{t-1}$	0.003		0.004
	[0.08]		[0.09]
Tax Increase$_{t-2}$	0.085**		0.083**
	[2.13]		[2.14]
Tax Decrease$_{t-1}$		0.015	0.020
		[0.42]	[0.56]
Tax Decrease$_{t-2}$		-0.043	-0.036
		[-1.45]	[-1.14]
ΔLn(Assets)	0.221***	0.221***	0.222***
	[7.63]	[7.75]	[7.66]
ΔMTB	0.040***	0.040***	0.039***
	[13.06]	[12.10]	[11.95]
ΔROA	0.252***	0.252***	0.251***
	[7.12]	[7.18]	[7.17]
Observations	7,358	7,358	7,358
R-squared	0.200	0.199	0.200
NEO-Firm FE	Y	Y	Y
Industry-Year FE	Y	Y	Y

Table 12. Elasticity of US CEO Compensation in the Federal Net-of-Tax Rate

This table shows the elasticity of US CEO compensation in the net-of-personal-income-tax rate following the framework by Frydman and Molloy (2011). The dependent variable is transformed CEO total compensation, Δln(TDC1), control variables include Assets, MTB, and ROA, , Δ denotes difference, Ln(.) is the natural logarithm, and NOT_t is the after-tax multiple for pay $(1-\tau_{m,f,t})$ for CEO m in year t (f denotes federal). Columns 1 and 2 do not include fixed effects. Columns 3 and 4 include firm and year fixed effects. Robust standard errors are clustered at the state level. Appendix 1 provides variable definitions. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

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	(1)	(2)	(3)	(4)
	US Federal Tax Changes Only			
Variables	ΔLn(TDC1)			
Ln(NOT_{t-2}/ NOT_{t-1})	-0.231	-0.238	-0.047	-0.076
	[-1.43]	[-1.47]	[-0.07]	[-0.12]
Ln(Initial Pay)		-0.002		0.016**
		[-0.53]		[2.11]
ΔLn(Assets)	0.375***	0.373***	0.346***	0.347***
	[16.82]	[16.63]	[16.92]	[16.95]
ΔMTB	0.073***	0.073***	0.075***	0.075***
	[11.74]	[11.73]	[14.36]	[14.42]
ΔROA	0.428***	0.428***	0.392***	0.390***
	[8.80]	[8.79]	[9.38]	[9.32]
Observations	23,384	23,382	23,187	23,185
R-squared	0.035	0.035	0.090	0.090
Firm FE	N	N	Y	Y
Year FE	N	N	Y	Y

Table 13. Elasticity of US CEO Compensation in the US State Inverse Net-of-Tax Rate

This table shows the elasticity of US CEO compensation in the net-of-personal-income-tax rate. The dependent variable is transformed CEO total compensation, Δln(TDC1), control variables include Assets, MTB, and ROA. Δ denotes difference, Ln(.) is the natural logarithm, and NOT_t is the after-tax multiple for pay $(1-\tau_{m,f,t}-\tau_{m,s,t})$ for CEO *m* in year *t* (*f* (*s*) denotes federal (state)). In Columns 1 and 2 we consider large tax rate changes only (at least one percentage point) and so set $NOT_{t-s}/NOT_{t-(s-1)}$ = 1 for all CEO-year observations when the tax rate change is less than one percentage point. In Column 3 the calculation of NOT_t considers all tax changes of any size. All specifications include CEO-Firm and Industry-Year fixed effects. Robust standard errors are clustered at the state level. Appendix 1 provides variable definitions. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)
	Large (≥1%) State Tax Changes		All State Tax Changes
Variables	ΔLn(TDC1)		ΔLn(TDC1)
Ln(NOT_{t-2}/NOT_{t-1})	0.041	0.096	0.315
	[0.08]	[0.20]	[0.75]
Ln(NOT_{t-3}/NOT_{t-2})	0.906**	0.730**	0.405
	[2.30]	[2.01]	[1.20]
ΔLn(Assets)		0.327***	0.327***
		[12.42]	[12.41]
ΔMTB		0.074***	0.074***
		[9.55]	[9.57]
ΔROA		0.393***	0.393***
		[5.87]	[5.87]
Observations	22,575	22,291	22,291
R-squared	0.177	0.196	0.196
CEO-Firm FE	Y	Y	Y
Industry-Year FE	Y	Y	Y

Table 14. Upside and Downside Elasticities of US CEO Pay in the US State Inverse NOT

This table shows the upside and downside (for state tax increases versus decreases) elasticities of US CEO compensation in the inverse net-of-personal-income-tax rate. The dependent variable is transformed CEO total compensation, Δln(TDC1), control variables include Assets, MTB, and ROA. Δ denotes difference, Ln(.) is the natural logarithm, and NOT_t is the after-tax multiple for pay $(1 - \tau_{m,f,t} - \tau_{m,s,t})$ for CEO m in year t (f (s) denotes federal (state)). We consider large tax rate changes only (at least one percentage point) and so set $NOT_{t-s}/NOT_{t-(s-1)}$ = 1 for all CEO-year observations when the tax rate change is less than one percentage point. Columns 1 and 2 (3 and 4) use a sample excluding observations with large tax decreases (increases). All specifications include CEO-Firm and Industry-Year fixed effects. Robust standard errors are clustered at the state level. Appendix 1 provides variable definitions. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively. Federal changes included in NOT are washed out by year FEs.

	(1)	(2)	(3)	(4)
	ΔLn(TDC1)			
VARIABLES	No Tax Decreases		No Tax Increases	
Ln(NOT_{t-2}/ NOT_{t-1})	0.200	0.226	0.315	0.318
	[0.40]	[0.48]	[0.66]	[0.68]
Ln(NOT_{t-3}/ NOT_{t-2})	2.571***	2.762***	-0.177	-0.647
	[2.92]	[3.50]	[-0.31]	[-1.45]
ΔLn(Assets)		0.321***		0.314***
		[12.64]		[10.18]
ΔMTB		0.075***		0.074***
		[9.23]		[11.17]
ΔROA		0.424***		0.399***
		[5.87]		[5.63]
Observations	20,976	20,705	20,544	20,303
R-squared	0.193	0.213	0.190	0.208
CEO-Firm FE	Y	Y	Y	Y
Industry-Year FE	Y	Y	Y	Y

Appendix 1: Variable Definitions

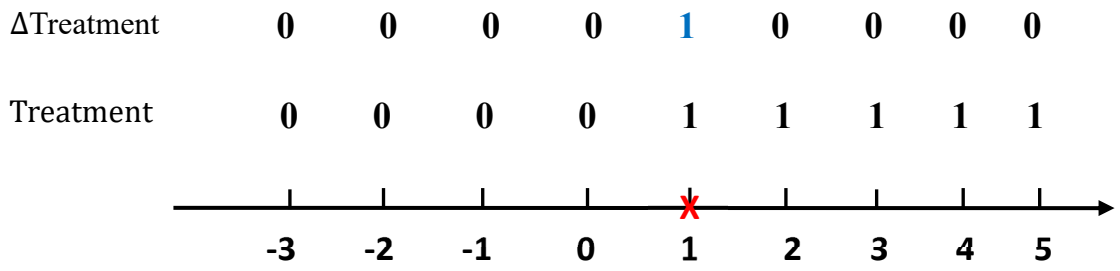
Assets	total book value of assets
Bonus	CEO discretionary bonus
Democrat Gov	dummy variable equal to one if the state had a democratic governor in a particular year, zero otherwise
Log(Assets)	the natural logarithm of total book assets
NonEqIncent	value of a CEO's cash performance pay in a given year
NOT	$NOT_t \equiv (1 - \tau_{f,t} - \tau_{s,t})$ means "net of tax", where $\tau_{f,t}$ ($\tau_{s,t}$) is the top marginal federal (state) tax rate at time *t*
Options	value of a CEO's options awards in a given year
Population	the total state population within a specific year
MTB	market value of equity plus book value of debt divided by the sum of the book values of debt and equity
ROA	net income scaled by total assets
SCash	the total cash of a given state in a specific year
SDebt	the total debt of a given state in a specific year
State GDP	the gross domestic product within a state-year
Stock	value of a CEO's stock awards in a given year
Tax Increase	a dummy variable equal to one if a CEO experienced a personal income tax rate increase (greater than one percentage point, and zero otherwise
Tax Decrease	a dummy variable equal to one if a CEO experienced a personal income tax rate decrease (greater than one percentage point), and zero otherwise
Tax Revenue	total tax revenue within a state-year
TDC1	total CEO compensation in a given year

Unemployment	the percentage of workers that are unemployed within a state-year

Appendix 2: Supplemental Figures and Tables

Figure A1. The First-difference Setting of the DiD Analysis

This figure illustrates the correspondence of the level of treatment dummy and the first difference in the treatment dummy. The upper (lower) panel shows the event study based on a single (two) event(s) as indicated by the red cross(es) on the time axis. *Treatment* is the treatment dummy (counter) variable that equals one (the number of treatments) after the corresponding shock(s). *Δ Treatment* is the first difference in *Treatment* and indicates an appearance of a new shock.



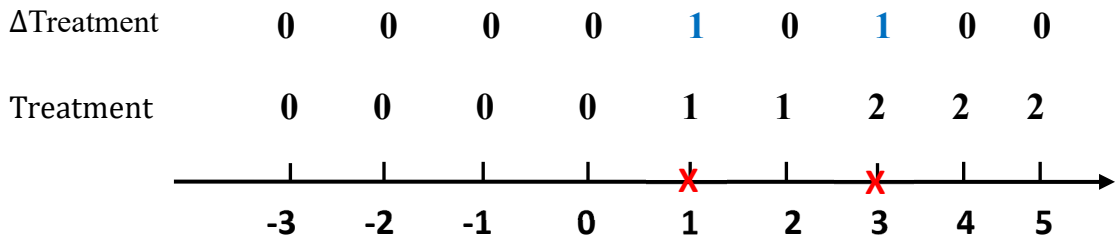
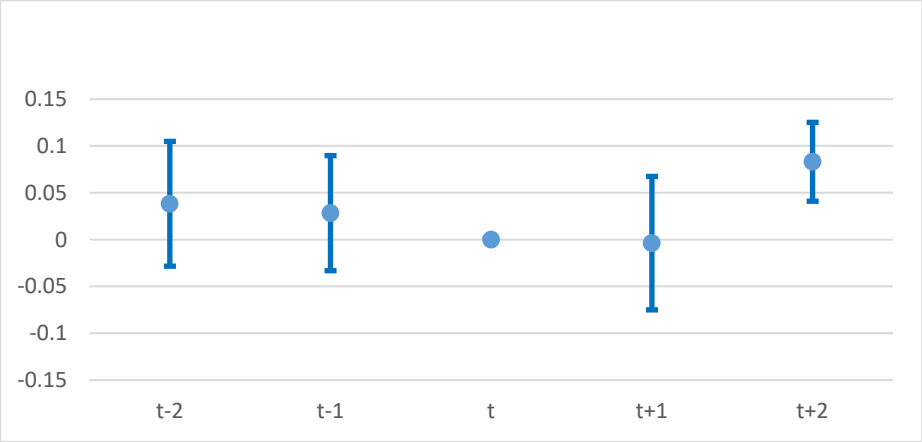


Figure A2. Pre-trends for Stacked DiD Analysis: Personal Income Tax Shocks and CEO Compensation

This figure illustrates the effect of state personal income tax rates on CEO compensation. Using a stacked DiD approach, ΔLn(TDC1) is regressed on yearly indicator variables (relative to the year of a tax shock), and CEO-firm and industry-year fixed effects included. The y-axis plots the coefficient estimates on each yearly indicator variable. The x-axis shows the year relative to the shock to state personal income tax rates. Year t is the benchmark year. The sample is at the CEO-firm-year level. Treated firms are those headquartered in states with large changes in personal income tax rates (at least 1%), and control firms are those headquartered in remaining states. The error bars illustrate the 90% confidence intervals of the coefficient estimates. The confidence intervals are based on standard errors clustered at the state level.

Panel A. Tax Increases



Panel B. Tax Decreases

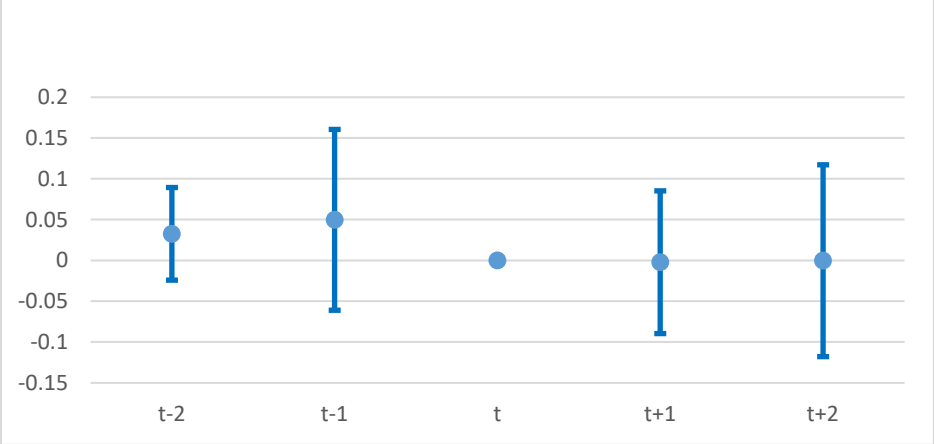


Table A1. Stacked DiD: CEO Compensation Responsiveness to State Personal Income Tax Changes

This table shows the effects of changes in personal US state income tax rates on CEO compensation, using a stacked DiD approach (Cengiz et.al., 2019). For each large tax increase or decrease (at least 1%), a [-2, +2] stack window is used. States with any large changes (increases or decreases) at any point within a stack window are excluded (for example, if a state has large tax changes in both 2010 and 2012, both shocks are excluded from the test sample). CEOs of firms headquartered in states with large changes are in the treatment group. The remaining CEOs are in the control group. For each stack, Tax Increase (Decrease) is a dummy variable that equals one if a CEO's state personal income tax rate increases (decreases) by at least one percentage point at the central year of the stack, and zero otherwise. $Post_1$ ($Post_2$) is an indicator variable for the first (second) year following a large tax shock. Total pay is TDC1 in Execucomp database. The dependent variable is ΔLn(TDC1) and the control variables are transformed Assets, MTB, and ROA, Δ denotes difference, and Ln(.) is the natural logarithm. All specifications include CEO-Firm and Industry-Year fixed effects. Robust standard errors are clustered at the state level. Variables are defined in Appendix 1. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)
VARIABLES	ΔLn(TDC1)	ΔLn(TDC1)
Tax Increase x $Post_1$	-0.010	
	[-0.30]	
Tax Increase x $Post_2$	0.073***	
	[4.11]	
Tax Decrease x $Post_1$		-0.015
		[-0.29]
Tax Decrease x $Post_2$		0.017
		[0.55]
ΔLn(Assets)	0.279***	0.263***
	[6.17]	[8.47]
ΔMTB	0.107***	0.084***
	[7.93]	[7.58]
ΔROA	0.516***	0.444***
	[4.69]	[4.51]
Observations	22,609	34,394
R-squared	0.271	0.272
CEO-Firm FE	Y	Y
Industry-Year FE	Y	Y

Table A2. Stacked DiD: CEO Pay and State Tax Shocks (A Narrative Approach)

This table shows the effects of changes in personal income tax rates on CEO compensation using a stacked DiD approach (Cengiz et.al., 2019). We define exogenous state tax shocks following the narrative approach by Romer and Romer (2010) and Giroud and Rauh (2019), and only these shocks are included in the test sample. For each large tax increase or decrease (at least 1%), a [-2, +2] stack window is used. States with any large changes (increases or decreases) at any point within a stack window are excluded (for example, if a state has large tax changes in both 2010 and 2012, both shocks are excluded from the test sample). CEOs of firms headquartered in states with large changes are in the treatment group. The remaining CEOs are in the control group. For each stack, Tax Increase (Decrease) is a dummy variable that equals one if a CEO's state personal income tax rate increases (decreases) by at least one percentage point at the central year of the stack, and zero otherwise. $Post_1$ ($Post_2$) is an indicator variable for the first (second) year following a large tax shock. Total pay is TDC1 in Execucomp database. The dependent variable is Δln(TDC1) and the control variables are transformed Assets, MTB, and ROA, Δ denotes difference, and Ln(.) is the natural logarithm. All specifications include CEO-Firm and Industry-Year fixed effects. Robust standard errors are clustered at the state level. Variables are defined in Appendix 1. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)
VARIABLES	ΔLn(TDC1)	ΔLn(TDC1)
Tax Increase x $Post_1$	0.001	
	[0.04]	
Tax Increase x $Post_2$	0.084***	
	[5.25]	
Tax Decrease x $Post_1$		0.004
		[0.08]
Tax Decrease x $Post_2$		0.005
		[0.13]
ΔLn(Assets)	0.276***	0.217***
	[6.03]	[6.90]
ΔMTB	0.107***	0.086***
	[7.88]	[5.84]
ΔROA	0.517***	0.419***
	[4.67]	[4.27]
Observations	22,491	27,044
R-squared	0.271	0.268
CEO-Firm FE	Y	Y
Industry-Year FE	Y	Y

Table A3. Stacked DiD: CEO Pay and State Tax Shocks Using Neighboring Control States

This table shows the effects of changes in personal income tax rates on CEO compensation using a stacked DiD approach (Cengiz et.al., 2019). Only neighboring control states are included in the test sample. For each large tax increase or decrease (at least 1%), a [-2, +2] stack window is used. States with any large changes (increases or decreases) at any point within a stack window are excluded (for example, if a state has large tax changes in both 2010 and 2012, both shocks are excluded from the test sample). CEOs of firms headquartered in states with large changes are in the treatment group. The remaining CEOs are in the control group. For each stack, Tax Increase (Decrease) is a dummy variable that equals one if a CEO's state personal income tax rate increases (decreases) by at least one percentage point at the central year of the stack, and zero otherwise. $Post_1$ ($Post_2$) is an indicator variable for the first (second) year following a large tax shock. Total pay is TDC1 in Execucomp database. The dependent variable is Δln(TDC1) and the control variables are transformed Assets, MTB, and ROA, Δ denotes difference, and Ln(.) is the natural logarithm. All specifications include CEO-Firm and Industry-Year fixed effects. Robust standard errors are clustered at the state level. Variables are defined in Appendix 1. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

VARIABLES	(1) ΔLn(TDC1)	(2) ΔLn(TDC1)
Tax Increase x $Post_1$	-0.013	
	[-0.39]	
Tax Increase x $Post_2$	0.058**	
	[2.48]	
Tax Decrease x $Post_1$		-0.043
		[-0.81]
Tax Decrease x $Post_2$		-0.022
		[-0.52]
ΔLn(Assets)	0.281***	0.268***
	[6.57]	[10.83]
ΔMTB	0.105***	0.086***
	[6.17]	[6.55]
ΔROA	0.463***	0.460***
	[2.84]	[4.25]
Observations	12,368	27,886
R-squared	0.310	0.288
CEO-Firm FE	Y	Y
Industry-Year FE	Y	Y