A Re-examination of Firm Size and Taxes

Fabio B. Gaertner[a] Brent Glover[b] Oliver Levine[a]

[a] *University of Wisconsin–Madison, Wisconsin School of Business*
[b] *Carnegie Mellon University, Tepper School of Business*

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ABSTRACT

We document that larger firms pay substantially lower cash effective tax rates (cash ETRs) in the long-term than do smaller firms. This pattern in long-term cash ETRs is robust to various specifications, but vanishes when cash ETRs are measured over a single year. While the association between long-run cash ETR and size is stable across different combinations of commonly used control variables, the association between one-year cash ETR and size varies widely depending on which control variables are included. Over a ten-year period, firms in the largest decile pay 10.8 p.p. (26 percent) lower taxes than those in the smallest decile, while this gap balloons to 14.4 p.p. (35 percent) for the largest 1 percent of firms. The relation between firm size and taxes over the long run cannot be explained by foreign operations, asset tangibility, R&D spending, capital structure, net operating loss carryforwards, or releases in the valuation allowance. We find profitability explains near a quarter of association between long-run cash ETR and size. Meanwhile, about 80 percent of the association between size and taxes can be explained by the magnitude of losses within the horizon period. Overall, our results suggest large firms pay fewer taxes over the long run primarily by avoiding losses, potentially by mitigating the negative consequences of tax convexity.

1. Introduction

Recognizing that firm size carries political implications that may affect the corporate tax function, decades of research has considered the association between firm size and taxes. Despite repeated arguments in politics and the media suggesting large firms use their wealth to secure economic rents via excessive tax avoidance, the academic literature has failed to find a consistent relation between size and tax rates in the data. According to a recent meta-analysis of 49 empirical corporate tax studies in the U.S., only 18 percent of studies find a negative association between firm size and taxes, while 41 percent find a positive association, with the remaining plurality of studies finding no clear association (Belz et al. 2019).

In this study, we reconsider the association between firm size and taxes by employing a long-run measure of cash effective tax rates over a 10-year horizon. Our sample begins in 1988 and ends in 2017, corresponding to the time period between the Tax Reform Act of 1986 (TRA 86) and the Tax Cuts and Jobs act of 2017 (TCJA), and therefore ensuring stability in the tax system. In contrast to the one-year rate commonly used in existing studies, long-term tax rates more accurately measure a firm's true tax burden by smoothing year-to-year variation and reducing sample selection problems caused by years with losses (Dyreng et al. 2008). Firm size is measured using the market value of assets. After estimating the relation between cash effective tax rates (cash ETRs) and firm size, we find larger firms pay substantially lower cash ETRs in the long-term than do smaller firms. Our findings are economically significant. Over a ten-year period, firms in the largest decile pay 10.8 percentile points (26 percent) less in taxes than those in the smallest decile. This gap balloons to 14.4 percentile points (35 percent) for the largest 1 percent of firms. This pattern of decreasing tax rates across increasing size portfolios is monotonic, and is robust to multiple specifications. We find similar results after employing alternate measures of firm size, adjusting for special items, and using alternate measures of taxation. We also find similar results when computing cash ETR across 7-year, 5-year, and 3-year horizons.

When we measure cash ETR on an annual basis, we find the consistent pattern documented above vanishes.[1] Using a multivariate setting, we find the association between long-run cash ETR and size is statistically significant and negative across 1,024 possible combinations of ten control variables typically used in the literature. Meanwhile, the corresponding association between one-year cash ETRs and size varies between significantly negative, insignificant, and significantly

[1] When restricting the annual cash ETR analysis to the set of firms with non-missing long-run cash ETRs, we find a negative relation between size and cash ETR, but it is only about 30 percent as strong.

positive depending on which controls are included; although the distribution centers around zero. Thus, inconsistencies in the association between firm size and taxes reported in prior literature appear to be largely driven by the use of annual effective tax rates.

Next, we examine the relation between firm size and taxes over time. Rather than computing 10-year rolling measures of cash ETR, we compute cash ETR once per firm per decade for the three decades within our sample period. When examining the relation between firm size and cash ETR by decade, we find a differential in taxes between small and large firms of 13.3 p.p. in the 1980s, a differential of 10.6 p.p. in the 1990s, and a 13.6 p.p. gap in the 2010s. However, while inequality in taxes with respect to firm size does not appear to be growing over time, the linearity of the association holds primarily in the last two decades, as much of the first decade gap is caused by the large gap between the two smallest size deciles in the 1980s.

In subsequent tests, we explore a number of potential explanations for the negative relation between firm size and taxes. Using two-way sorts and multivariate regression, we show the negative association between firm size and long-run cash ETR cannot be explained by foreign operations, asset tangibility, R&D spending, capital structure, net operating loss carryforwards, or releases in the valuation allowance.

Motivated by Graham and Smith (1999), who simulate the effects of tax convexity on firm taxes, we examine losses as a potential determinant of the association between firm size and taxes. Tax convexity occurs when firms are taxed on their profits, but are not fully credited for their losses. The asymmetric tax treatment of profits and losses means that a firm with some loss-making years may pay a greater percentage of its pretax income in taxes over the long-run than a firm with consistent profits. As Graham and Smith (1999) show, firms are most likely to have convex functions when they are small, have expected income near zero, and alternate between profits and losses. We find that a significant portion of the size-ETR relation can be explained by the instance of losses: losses lead to higher ETRs, and smaller firms have a higher incidence of losses. However, the explanatory power of losses is not solely due to the lower average profitability or higher accumulation of NOLs by smaller firms. Specifically, the size effect remains significant even after controlling for the firm's average profitability. In addition, little of the size effect can be explained by either tax loss carryforwards or the NOL benefit measure of Heitzman and Lester (2021), possibly because Compustat-based estimates of net operating losses have substantial measurement error (Heitzman and Lester 2021). Overall, our findings with respect to taxes and firm size appear to be primarily driven by tax convexity resulting from the asymmetric treatment of profits and losses in the tax code.

Our study adds to prior literature on the effects of firm size and taxes. A significant strand of the tax literature explores firm characteristics that determine corporate tax outcomes, typically measured as the cash or GAAP effective tax rate.[2] Several of these studies directly investigate the role of firm size on corporate taxes (e.g., Omer et al. 1993; Rego 2003). Further, firm size is included as a covariate in nearly all determinant models of corporate effective tax rates. Despite a long line of research in this area, the existing empirical literature has not found firm size to be a consistent determinant of effective tax rates. We add to this literature by providing new evidence on the relation between firm size and taxes using a long-term measure of effective tax rates. Contrary to most studies in this area, we find a consistent negative relation between firm size and taxes. We also show this relation does not appear at the one-year horizon, providing guidance to future empirical studies.

The findings in this study also speak to recent legislative efforts to modify the corporate tax code. While seeking to advance such proposals, members of Congress have highlighted perceived inequalities in the tax code, and particularly the role of firm size. Our results speak directly to this debate. Specifically, we show there is indeed a negative association between firm size and taxes, consistent with recent political arguments. However, our results suggest that the lower rates paid by large firms largely reflects an ability to avoid and manage losses rather than the abusive tax practices that are often the focus of policymakers. While our study cannot speak to the degree to which firms engage in aggressive tax avoidance or income shifting, our evidence suggests that these practices are unlikely to be the primary driver of the tax rate inequality with respect to size that we document.

Our paper is related to Christensen et al. (2021) and van der Geest and Jacob (2020). Both studies find net operating losses are primarily responsible for low effective tax rates, although neither explores the relation between losses and size. While the two prior studies show NOLs are associated with lower taxes in the short-run, our study suggests the instance of losses, which leads to NOLs, is associated with higher taxes over the long-run. Our finding suggests large firms potentially benefit by avoiding having to use NOLs, and consequently mitigating the negative effects of tax convexity. In addition, our results reveal the importance of appropriately accounting for losses in studying the determinants of the effective tax rate. In particular, simply excluding observations in years with losses may lead to a sample selection problem—a concern highlighted by Henry and Sansing

[2] See Wilde and Wilson (2018) for a recent review of the literature on corporate tax planning.

(2018) in explaining the downward trend in ETRs over time—and make it difficult to detect the effect losses have on a firm's tax burden. The use of long-term rates allows for an exploration of the effect of losses on tax rates while simultaneously mitigating sample selection problems.

A significant literature in economics, going back at least to Hall and Jorgenson (1967), explores the role of taxation in corporate investment and decision-making. Typically, these studies assume that all firms face the same tax rate. If larger firms face a lower effective tax rate, as we find in this study, this has important implications for the effects of corporate taxes on real economic outcomes. This is explored in the contemporaneous work of Glover and Levine (2021). They develop a model in which larger firms endogenously choose higher tax avoidance and show that avoidance leads to an inefficient allocation of capital and higher industry concentration.

2. Background and Prior Literature

Academics have long pointed out that large firms face a double-edged sword when it comes to taxes. On one hand, large firms have additional resources and political power that can help them secure tax benefits. On the other, they are natural political targets, which could result in additional taxes for large firms. Both of these mechanisms can be regularly observed in practice. A number of features of the tax code benefit large firms disproportionately. For example, recent research shows the benefits of subsides for oil, gas, and coal production are concentrated within a handful of large firms (Kotchen 2021). Meanwhile, (Dyreng et al. 2021b) show that a small percentage of large firms drive the lion's share of income shifting activity in the U.S. The political sensitivity of large firms can also be seen in the taxation of international profits, where large multinationals benefited substantially from the tax treatment of unrepatriated foreign profits for decades, until changes to the tax code as part of the Tax Cuts and Jobs Act of 2017 (TCJA) addressed perceived tax abuses by these same companies through the GILTI and BEAT provisions.

Political arguments over the corporate tax generally center around notions of equity and fairness. For example, the TCJA was primarily motivated around the idea of competitive fairness, and was designed to help level the global playing field for U.S. multinational corporations. Meanwhile, the Made in America Tax Plan, recently released by the Biden administration, is largely motivated by the premise that "the largest, most profitable U.S. companies face lower tax rates than ordinary Americans" (U.S. Treasury 2021). Through the proposed changes to the tax code, the proposal would "ensure that large, profitable companies pay a baseline amount of taxes." The Made in America Tax Plan includes key elements of the Real Corporate Profits Tax plan, proposed by

Senator Elizabeth Warren. The proposal, which like the Made in America Tax Plan also calls for a minimum tax tied to book income, is not only motivated by the premise that large corporations pay low tax rates, but also that the current approach to taxing large firms harms the competitive environment in the U.S.

Tax advocacy groups regularly promote the idea that large corporations benefit excessively from the current tax system, and have so for decades. For example, as early as 1985, the Citizens for Tax Justice released a paper entitled "Corporate Taxpayers & Corporate Freeloaders: Four Years of Continuing, Legalized Tax Avoidance by America's Largest Corporations 1981–84," arguing for the enactment of a minimum tax on large corporations (McIntyre and Wilhelm 1985). The report, in part, served as the motivation for alternative minimum tax established in the Tax Reform Act of 1986 (TRA 86), which included a book income adjustment similar to recent tax proposals following the TCJA. Much of this negative sentiment over the taxation of large corporations remained well after the TRA 86. An analysis of effective tax rates for the Fortune 500 conducted just prior to the TCJA finds that "the tax breaks claimed by these companies are highly concentrated in the hands of a few very large corporations" (Gardner et al. 2017). In a subsequent report conducted after the TCJA, the Institute of Taxation and Economic Policy finds that "at least 55 of the largest corporations in America paid no federal corporate income taxes in their most recent fiscal year despite enjoying substantial pretax profits in the United States" (Gardner and Wamhoff 2021). In addition to affecting tax policy, these reports have also been regularly featured in the news media, thus influencing public opinion.

Despite numerous recent arguments in politics and the media suggesting large corporations use their vast resources to avoid remitting their fair share to tax authorities, empirical research on this topic is largely inconclusive, and in most cases suggests the opposite. There is now a large literature exploring the relation between firm size and taxes. This literature follows the seminal work of Zimmerman (1983), examining the potential link between firm size and taxes. Following up on the work of Alchian and Kessel (1962) and Jensen and Meckling (1976), who suggest large firms are subjected to greater government scrutiny than smaller firms, Zimmerman (1983) argues corporate taxes are a component of political costs. According to Zimmerman (1983), variation in effective tax rates with respect to size provides a partial measure of a firm's success in the political process; although he notes other factors play out in the political process as well (e.g., antitrust regulation, government subsidies and contracts, tariffs, etc.). Using a sample from 1947 to 1981, Zimmerman (1983) finds that largest firms have the highest effective tax rates, consistent with the political cost hypothesis.[3]

Numerous studies examining size and taxes have followed Zimmerman (1983), many of which find similar conclusions. For example, Omer et al. (1993) extend Zimmerman's analysis into the mid-1980s and concludes that large firms are disproportionately negatively affected by the corporate tax. Rego (2003) extends the analysis of firms size and taxes to the post-TRA 86 period and also finds a positive relation between firm size and taxes. Other studies, however, fail to find a significant relation between firm size and taxes. For example, Shevlin and Porter (1992) use a matched sample and find similar trends in rates for both small and large firms. Gupta and Newberry (1997) re-examine the issue of firm size and taxes and fail to find a significant relation. Further, a number of earlier studies find the opposite result, suggesting larger firms have greater resources to influence the political process to achieve lower taxes (e.g., Siegfried 1974; Porcano 1986).

As the number of tax avoidance studies has soared, so has the literature on firm size and taxes, as virtually every academic study exploring determinants of corporate tax avoidance examines firm size as a covariate. Findings from these studies, however, yield little consensus. After analyzing a large number of empirical tax studies in the U.S., Belz et al. (2019) finds 41 percent of studies find a positive relation, 18 percent of studies find a negative relation, and the remaining find evidence for either, neither, or both.[4]

In summary, the association between firm size and taxes is of interest to policymakers, academics, and the public in general. Perceptions of this relation affect public opinion as well as tax policy. Meanwhile, the empirical evidence on this important issue is inconclusive. Motivated by the importance of this topic, the inconsistency of findings in the prior literature, and by recent political arguments and reporting in the media, in this study we re-examine the relation between firm size and taxes.

3. Empirical Analysis

3.1. Effective Tax Rates

Our goal in this paper is to examine the association between firm size and corporate income taxes. Like the vast majority of the prior literature exploring the association between firm size and taxes, our study focuses on the relation between effective tax rates and firm size. While prior

[3]While Zimmerman (1983) is likely the most influential study of firm size and taxes, it is certainly not the first. Preceeding studies include Weiss (1979), U.S. Treasury (1978), Fiekowsky (1977), Cordes and Sheffrin (1983), Siegfried (1974), and Stickney and McGee (1982).

[4]See Belz et al. (2019) for the full list of papers examined.

literature employs various specifications of ETRs, the notion behind all ETR measures is the same: to measure the average tax associated with a dollar of pretax income.[5]

We follow Dyreng et al. (2008) by employing a long-run measure of cash effective tax rates as our primary measure. That is, we divide the sum of cash taxes paid over ten years by the sum of pretax income for the corresponding time period. We vary the measurement window of cash ETR in our main analysis (i.e., 10, 7, 5, 3, and 1 years), although we note that Dyreng et al. (2008) find annual cash ETRs to be poor predictors of long-run cash effective tax rates and, indicating short-run measures are not accurate proxies for long-run tax avoidance. All ETR measures are set to missing when either the numerator is negative or the denominator is non-positive. ETRs greater than 1 are set to 1. As a result, ETR is always a value between 0 and 1.

Using a long-horizon ETR measure allows us to examine taxes over the long-run. This approach also enables us to compute more stable measures of effective tax rates, as firms often experience significant year-to-year variations in annual ETRs and ETRs are not well-defined when the denominator is non-positive. Employing cash-based ETRs also helps us navigate around commonly known pitfalls of evaluating corporate taxation using income tax expense. That is, unlike GAAP-based measures of tax expense, our measure is unaffected by tax accruals or deferred taxes, which are well known to obscure the mapping between tax expense and tax avoidance activities.

As Dyreng et al. (2008) note, cash taxes paid is also an imperfect measure of tax avoidance, as it captures tax settlements with the IRS related to prior fiscal periods. However, these distortions in the use of cash taxes paid are most likely to occur in short estimation windows. As the measurement period of cash ETR increases, the income relating to these taxes will more likely be included in the same ratio as the numerator. Another drawback of using a long-run measure of cash effective tax rates is that requiring a longer time series institutes a survivorship bias in the sample, limiting the generalizability of our findings to younger firms. Because younger firms are less likely to pay taxes, as they run large losses in the beginning of their life cycle, we are less concerned with this bias.

3.2. Sample Selection

Our sample selection criteria is summarized in Table I. Table I (Panel A) presents the basis for our base sample. We begin with all U.S.-incorporated firm-year observations in Compustat beginning in 1988 and ending in 2017; excluding financials, utilities, and quasi-governmental firms.

[5] The underlying assumption in studies of ETRs is that they correlate to firms' tax avoidance activities. Recent research, however, suggests this may not be the case, at least for a set of firms in the extreme low distribution of ETRs (e.g. Christensen et al. 2021; van der Geest and Jacob 2020).

The time period criteria ensures that all observations fall after the TRA 86 and before the TCJA, ensuring a relatively stable tax system across the sample. We eliminate firms with missing cash taxes paid or missing pretax income, as these comprise our primary measure. We also require firms to have non-missing operating income, book assets greater than $50 million (in 2017 real dollars), non-missing market value of equity, and positive sales. These latter requirements increase the stability of firms in our sample, although our primary results are similar without imposing them.

Table I (Panel B) presents sample attrition for cash ETRs measured at different horizons from our base sample presented in Panel A. Because ETRs are undefined when pretax income is non-positive, we require positive denominators. This requirement creates most of the attrition in Panel B. We also require taxes paid to be non-negative, although this requirement has a much smaller effect. After these requirements, we are left with 58,436 firm-year observations (7,334 unique firms) for 1-year cash ETR, 39,108 firm-year observations (4,452 firms) for 5-year cash ETR, and 23,927 firm-year observations (2,679 firms) for 10-year cash ETR.

Panel C reports the number of observations for 10-year and 1-year measures across Fama-French 17 industry groupings in columns (1) and (3), respectively. Columns (2) and (4) represent the number of firm-year observations in any given industry as a percentage of total observations for each respective sample. The table shows little industry clustering across either 10-year or 1-year ETR measures. Firms in Mining and Fabricated Products comprise the smallest portion of the sample across both measures, while firms in Business Equipment are the most represented across both measures as well. Overall, we see little difference in the industry composition of both samples. Column (5) shows the fraction of observations in the 10-year sample over observations in the 1-year sample, by industry. We see that these estimates tend to vary between 40-50 percent. The 10-year sample represents about 41 percent of the number of observations contained in the 1-year sample.

Table I (Panel C) also shows the economic significance of the 10-year sample, relative to the the 1-year sample. Columns (6) and (7) represent the mean market value of assets for firm-year observations in any given industry for each respective sample, while Column (8) presents the fraction of the numbers presented in both columns. From this we can see that firms in the 10-year sample are generally between 50-100 percent larger than firms in the 1-year sample across industries and about 83 percent larger overall. Column (9) presents the total market value of assets for long-run ETRs as a percentage of the total market value of assets for firms in the 1-year sample, by industry. Here we see that the bulk of economic activity in the 1-year sample is represented in the 10-year sample. Overall, firms in the 10-year sample comprise 75 percent of the total market value of assets in the 1-year sample.

3.3. *Firm Size and Taxes*

Table II (Panel A) presents average cash ETRs by size decile, while Figure 1 displays the corresponding graphical representation. While in later tests we focus on long-run estimates of cash ETR, here we employ five different estimation horizons: 10-year, 7-year, 5-year, 3-year, and 1-year. Firm size is defined as the market value of assets and size deciles are constructed annually. Standard errors and t-statistics are estimated using bootstrapping to address the overlapping nature of the multi-year measures and are reported alongside the estimates.

Here we see that average cash ETR decreases monotonically as the measurement window decreases, from 0.351 for 10-year ETR to 0.295 for the 1-year measure. The median, however, is stable across the 10-year, 7-year, and 5-year measures, and drops off for the 3-year measure and even more so for 1-year ETR. The standard deviation is also stable across the three longest windows, and increases for shorter measurements.

Looking across deciles, we find that 10-year ETRs decrease as size increases. Firms in the smallest size decile face a long-run cash effective tax rate of 41.4 percent, while the corresponding average for firms in the largest size decile is 30.6 percent. The spread in averages between the largest and smallest deciles is both economically and statistically significant (i.e., −10.8 percentage points). This difference is equivalent to about 31 percent of the overall mean for the variable and 54 percent of the standard deviation. The gap in taxes across size grows even larger when contrasting ETR averages between firms in the top 1 percentile of the size distribution and those in the smallest decile (i.e., −14.4 p.p.). This alternate comparison yields a difference in ETRs equivalent to 41 percent of the overall mean for 10-year ETR and 72 percent of the standard deviation.

When we turn to 7-year ETRs, we again find that ETRs decrease as size increases. The spread between the largest and smallest size deciles is slightly lower than that of 10-year ETR, but remains economically and statistically significant (i.e., −9.8 p.p.). The spread between firms in the top 1 percentile of size and in the smallest decile is also similar (i.e., −12.1 p.p.).

Averages of 5-year ETRs across size deciles follow the same downward monotonic patterns we observe in the two longer ETR windows. The difference in ETRs between the largest and smallest size deciles is also statistically significant, but the magnitude is smaller (i.e., −8.6 p.p.). The difference in ETRs between firms in the top size percentile and those in the lowest size decile is also higher than that of the extreme deciles (i.e., −10.8 p.p.).

The 3-year ETR averages across deciles, though also decreasing in size, decrease at a substantially slower rate. The difference between the two extreme deciles is substantially lower than in that of the three longer measurement-windows (i.e., -4.9 p.p.), while the spread between the top size percentile and the smallest size decile is significantly lower as well (i.e., -6.1 p.p.). Both differences however are still statistically significant.

While the graphs presented in Figure 1 for each of the multi-year ETRs have a visibly negative slope, representing the negative relation between ETRs and size, the graph for the 1-year ETR is essentially flat. As the Table II (Panel A) shows, 1-year ETR averages are virtually the same across each of the size deciles (i.e., about 29 percent). The spread between the top and bottom deciles is no longer economically or statistically significant. The same is the case for the spread between the top percentile and the bottom decile.

In Panel B of Table II we examine a number of alternative specifications. We use a tax preference measure, following Henry and Sansing (2018), and find consistent results. We also compute averages for 1-year ETRs using the 10-year sample, mitigating inconsistencies in results due to sample differences.[6] After accounting for sample differences, we find a small size effect. For example, the spread in ETRs between the largest and smallest deciles is only -3.1 p.p., or less than a third of the difference in 10-year ETR. In specifications shown under columns (3), (4), and (5) we employ different measures of size while examining 10-year ETR. We find that while total book assets and sales yield lower size differentials than our base specification, using the market value of equity results in slightly higher spreads. Finally, we compute the 10-year after adjusting the denominator for special items and find a virtually identical pattern.

The results presented above suggest the relation between firm size and effective tax rates is only apparent over longer horizons. As the ETR measurement window increases, so does the spread between the top and bottom size deciles. Because prior literature on the association between taxes and size is mixed, we examine the stability of our results using a multivariate setting. In Figure 2, we plot the distribution of the size coefficients and corresponding t-stats of a regression of ETRs on size plus all possible combinations of ten control variables typically used in prior literature (e.g., Chen et al. 2010; Chyz et al. 2013). That is, the figure shows histograms for the size coefficient and t-stats for $2^{10} = 1,024$ regression specifications. Panels A and B plot the size coefficient and corresponding t-stats for cash ETR, respectively. Panels C and D plot respective distributions for book ETRs.

[6] The sample size decreases from the base specification because a number of firm-year observations with non-negative sums of pretax income over 10 years have non-positive pretax income for a single period.

As the figure shows, the coefficient on size is statistically significant and negative across 99.12% of all 1,024 possible covariate combinations. Meanwhile, the corresponding association between one-year cash ETRs and size varies between significantly negative, insignificant, and significantly positive depending on which controls are included; although the distribution centers around zero. As the figure shows, inconsistencies in the association between firm size and taxes reported in prior literature appear to be largely driven by the use of annual effective tax rates. As a result, our findings suggest future studies should employ long-run measures in settings where firm size is either of primary interest or an essential covariate. The histograms presented in Figure 2 also confirm the notion that larger firms experience lower effective tax rates than smaller firms. In addition to having public policy implications, our primary finding stands in contrast to most of the literature on the subject. As our results demonstrate, it is unlikely that large firms face political costs in the way of higher rates of taxation as often suggested by prior studies.

Studies of size and taxes often employ different time periods. In Figure 3, we examine how the association between size and taxes has changed over time. While our primary tests examine cash ETRs computed over a 10-year across firm-years, in Figure 3 we compute 10-year cash ETRs at the firm-decade level. That is, we divide our sample into three separate time periods (i.e., 1988–1997, 1998–2007, and 2008–2017), and compute 10-year ETRs once per firm for each decade. Figure 3 graphs the relation between firm size and ETRs across the three decades. The figure shows a negative relation between size and tax rates across each of three decades. However, this relation is less monotonic in 1988–1997, and is mostly attributed to the large ETRs faced by the smallest firms (i.e., those in the first size decile). The line depicting the relation between size and taxes for 1998–2007 has a similar slope as the one for 1988–1997, but the relation is more linear. We see similar linearity in the association between size and taxes for the 2008–2017 period, while the slope becomes more negative, indicating the strong monotonic relation between firm size and taxes is a relatively recent phenomenon. Beyond differences in the measurement window of ETRs, these results suggest that differences in sample periods are also responsible for differences in results relating size and taxes documented in prior literature.

3.4. Potential Determinants of the Association between Firm Size and Taxes

While the findings presented above indicate larger firms face lower ETRs, the analysis is silent on the factors driving this association. Recognizing the paucity of causal settings resulting in exogenous shocks to size, we turn to association tests to examine the extent to which known vehicles of tax avoidance explain our association of interest.

We regress 10-year ETR on the natural log of the market value of assets as well as industry (Fama French 17) and year fixed effects. The model yields a coefficient on firm size, which we use as a base case. We then include proxies for capital structure, tangible investment, foreign activity, innovation, and accumulated loss carryforwards and evaluate changes to the coefficient on size. If size merely captures a combination of these characteristics, then the coefficient on size should become less pronounced relative to the base case.

We measure capital structure as the mean of book leverage over assets. Tangible investment is measured by the mean ratio of CAPX over assets. We use two different measures of foreign activity: the mean fraction of foreign income as well as a foreign income indicator. Innovation is captured by the mean of R&D expense over sales. Finally, we use a number of variables designed to capture the effect of accumulated loss carryforwards, including: changes in tax loss carryforwards, a tax loss carryforward indicator, changes in estimated NOL benefits from Heitzman and Lester (2021), an NOL benefit indicator, as well as the mean probability of a valuation allowance release in the spirit of Drake et al. (2020). Details of the variable construction are provided in the appendix. While 10-year ETR is computed as the sum of the numerator over the sum of the denominator, aggregated over the measurement window, each of the covariates is computed using the average of the annual ratios over the corresponding 10-year period. We compute averages of the ratios for each covariate used, rather than aggregating numerators and denominators over time because, unlike ETRs, the timing of the numerator and denominator are properly matched. However, in untabulated tests we compute all covariates using a consistent approach as the one used in the calculation of ETRs and find similar results.

Table III presents descriptive statistics for our sample. The first few rows present descriptive statistics related to the computation of ETRs. The variables that follow are used in our analysis of tax avoidance vehicles, while the last six variables presented are used in subsequent analysis. As the table shows, book leverage for the mean firm in our sample is 22 percent of assets. Most firms (i.e., 63 percent) report some amount of foreign income and the amount of foreign income reported is significant (i.e., 21 percent of total income). Foreign income is right-skewed, as the median fraction reported is far lower than the mean (i.e., 9 percent of total income). R&D is also right-skewed, as most firms report no activity. We see that 59 percent of firms report accumulated loss carryforwards, the magnitude of which is economically significant (i.e., 7 percent of assets). Using the estimated NOL benefit yields lower estimates for the value of carryforwards, but the variable is available for a far greater number of observations. Estimates of releases in the valuation allowance are economically significant as well (i.e., 11 percent of assets), but are available for a much smaller portion of the sample.

Table IV reports correlation coefficients for the primary variables used throughout the study (Pearson above the diagonal and Spearman below). From the table we see that unscaled pretax income and taxes paid are largely a function of size. ETRs, however, are negatively correlated with size; consistent with the results reported in Table II. Also consistent with the decile analysis, we see that as the measurement window of ETRs increases, the association between firms size and taxes becomes less negative. Size is correlated with a number of firm characteristics, including those which are typically associated with tax avoidance. None of these correlations, however, is greater than 0.3. As the table shows, different proxies for the same construct are highly correlated (e.g., fraction foreign pretax income and Reporting foreign income [0,1]). None of the correlations between constructs appear to be substantial.

Column (1) of Table V reports regression estimates of 10-year cash ETR on log(MVA), controlling for industry and year effects. Bootstrapped t-statistics are reported in parentheses. Similar to our decile analysis, we again find a negative association between 10-year ETR and size. The coefficient on size is statistically significant, and implies that for a 1 percentage change in size, the 10-year ETR decreases by 1.8 percent. We see that a model of 10-year ETR as a function of size, industry, and year explains about 6 percent of the total variation in the dependent variable. We include measures of leverage, tangible investment, foreign income, and innovation in Column (2). The coefficient on size, accounting for these additional factors, increases slightly in magnitude and remains statistically significant. Here we see that tangible investment and innovation are associated with lower long-run ETRs, while the opposite is the case for the fraction of foreign income. We include variables designed to capture the effects of loss carryforwards in columns (3), (4), and (5). While our proxies are generally significant and imply that higher carryforwards are positively related to long-run ETRs, the coefficient on size is generally unaffected in all three scenarios.

The results from Table V suggest size is not merely a proxy for well known determinants of tax avoidance. This is more easily seen in Figure 4, which graphs the 10-year ETR across deciles for subsample splits of the characteristics examined in Table V. Panel A of the figure graphs ETRs across size for two subsamples, partitioned on average book leverage. As the figure shows, the slope of the graph of ETRs across size deciles is negative and similar for both partitions, indicating the association between size and taxes cannot be explained by differences in capital structure.

The remaining panels generate subsample splits for firms on average CAPX (Panel B), average R&D (Panel C), and average probability of VA releases (Panel F). Panel D creates subsamples for firms with and without foreign income. Panel E creates subsamples to evaluate NOLs; one where ETRs are adjusted for NOL benefits and one unadjusted. Across each measure, we see similar downward slopes on both subsamples, indicating the variables above cannot explain the previously documented association between firm size and taxes.

3.5. Tax Convexity and Profitability

As the results above indicate, the relation between firm size and taxes appears to be independent of major tax avoidance strategies commonly examined in the prior literature. In this subsection, we examine whether tax convexity plays a role in the results we document above. As Graham and Smith (1999) show, the linearity of the tax function with respect to taxable income is invariably tied to its profitability. A profitable firm with no tax avoidance opportunities faces a linear tax function, where the slope is the statutory tax rate.[7] In a system with no loss carryover provisions, there is no association between the tax liability and taxable income for loss firms. That is, in a "core tax structure," where there are no loss carries or avoidance opportunities, firms face a kink in the tax function around zero taxable income; zero tax liabilities as taxable income is non-positive, and a positive tax liability that is proportional to taxable income for positive income. Graham and Smith (1999) also show that common features of the tax code (e.g., loss carries and tax avoidance opportunities) smooth this kink, such that firms face a convex tax function around zero taxable income. As a result, firms face higher ETRs when their taxable income is near the convex area of the tax curve.

One key insight from their study is that firms can avoid this tax convexity penalty by increasing their taxable income to avoid the convex region of the tax curve. Graham and Smith (1999) show firms are most likely to have convex functions when they are small, have expected income near zero, and alternate between profits and losses.

As Table III shows, larger firms face less variation in pretax income, suggesting they are less likely to alternate between profits and losses. The table shows large firms are also less likely to incur losses. This can also be seen in Panels A and C of Figure 5, which show both the frequency and magnitude of losses by size, respectively. The frequency of loss is defined as the fraction of years (or number of years in Figure 5) the firm reports negative pretax income over the preceding

[7]This assumes no progressivity in the corporate tax code for firm with non-positive taxable income, which while not completely descriptive of the corporate tax bracket, is largely the case.

ten-year period. The magnitude of losses is defined as the sum of absolute losses over the sum of absolute losses and profits over the previous ten years, a quantity that ranges from 0 to 1 by construction. Panels A and C reports the sample composition within each size decile, as well as the top 1 percent, based on these loss measures. For Panel C, firms with zero losses are assigned to the first quantile, which represents 49.8 percent of the entire sample. The remaining sample is divided into quintiles based on the magnitude of losses and assigned to quantiles 2–6. Both approaches to measuring losses indicate that losses decrease as a function of size.

Meanwhile, the univariate effect of losses on long-run ETRs can be seen in Panels B and D of Figure 5. These panels report the ETR conditional on a given frequency of loss or quantile of loss magnitude. The dark grey bar reports the ten-year cash ETR, and the light grey bar reports the ten-year cash ETR adjusted for the change in the Heitzman and Lester (2021) NOL benefit over the ten-year period. As Panels B and D show, ETRs are increasing in both the frequency and magnitude of losses. Table III also shows a positive correlation between size and profitability. This suggests large firms might be more adept at avoiding tax convexity, resulting in lower ETRs. We test this more explicitly by adding proxies for tax convexity to our multivariate model from Table V. These specifications, presented in Table VI, include several proxies for the firm's exposure to tax convexity. The first is the measure created by Graham and Smith (1999): they use a regression analysis to estimate the expected percentage tax savings from a five percent reduction in the volatility of taxable income as a function of Compustat variables.[8] The next two proxies are measures of income volatility: the coefficient of variation of pretax income—the preferred measure of volatility used in Graham and Smith (1999)—and the standard deviation of the ratio of pretax income to lagged book assets. These measures are used because higher income volatility increases the likelihood a firm alternates between losses and profits, increasing the effect of tax convexity on its ETR. The last two proxies are the frequency and magnitude of losses, respectively, described above.

Table VI shows that each of our measures designed to capture tax convexity is positive and significant, suggesting tax convexity is associated with higher long-run ETRs. The Graham and Smith (1999) measure, in column (1), is statistically significant but provides little explanatory for the size effect or ETRs generally. The results in columns (2) and (3) reveal that higher volatility results in a significantly higher ETR. However, the coefficient on size decreases only modestly indicating volatility explains only part of why larger firms have lower ETRs. This means that large

[8]See Graham and Smith (1999), page 2256, Eq. (1) for details.

firms may have lower ETRs as a result of lower income volatility, for example through diversification or earnings smoothing, but this is unlikely to be the primarily explanation for the lower rate large firms face. In contrast, when we control for losses, as Dyreng et al. (2021a) do when evaluating the link between analyst following and ETRs, we find substantially weaker magnitudes on the coefficient on size.[9] Adding the frequency of losses reduces the size coefficient by about half, while controlling for the magnitude of losses explains most of the effect of size. That is notwithstanding the fact that all specifications already control for net operating losses, suggesting that controlling for losses using Compustat-based measures is an ineffective approach in capturing the full effect of losses on taxes.

Average profitability and frequency of losses are of course closely related: a firm with consistently higher average profits is, all else equal, less likely to make a loss in a given year. As large firms are typically more profitable, a natural question arises: do large firms have fewer losses, and in turn lower ETR, simply because they are more profitable? If this were the case, it would explain why losses, and not income volatility, explain most of the size effect on ETR.

To answer this question, in column (6) of Table VI we estimate our base model with the inclusion of the ten-year average profitability where profitability is measured as the ratio of pretax income over assets. We see that profitability is negatively associated with ETRs. However, the coefficient on size remains significant and the magnitude is reduced by only 22 percent from the baseline specification in Table V. This, combined with the results from the previous specification means that larger firms are not achieving lower ETRs simply by being more profitable, and in turn less prone to loss-making, than small firms.

Overall, the results in Table VI suggest loss avoidance is a significant driver of the association between firm size and ETRs. If larger firms can avoid the negative effects of tax convexity, then doing so would lead to lower long-run ETRs. Our findings with respect to losses indicate a possible link between size and tax convexity. However, because tax convexity is unobservable, our results should be interpreted with caution.

[9] While both studies show a link between ETRs and losses, Dyreng et al. (2021a) find that prior losses affect current annual ETRs; in contrast, we explore the effect of losses on contemporaneous long-term ETRs. Despite differences in the measurement of losses and ETRs, both studies find that losses contain explanatory power beyond that of machine-readable NOLs in a tax avoidance setting.

4. Conclusion

The notion that large corporations are able to leverage their vast resources to avoid paying their fair share is often portrayed in political circles and the media. These arguments have shaped prior tax legislation and continue to shape discussions of tax policy. Meanwhile, despite decades of research on this topic, the academic evidence to date is inconclusive. In this study, we add to prior literature by re-considering the effect of firm size on taxes.

Our approach is simple. We examine long-run measures of cash ETR across size portfolios constructed every year. Using this approach, we show there is a decreasing monotonic relation between firm size and tax rates. Over a ten-year period, firms in the largest decile pay 10.8 p.p. (26 percent) lower taxes than those in the smallest decile, while this gap balloons to 14.4 p.p. (35 percent) for the largest 1 percent of firms. Thus, consistent with arguments suggesting large corporations are well adept at avoiding taxes, our results show large firms indeed face significantly lower cash effective tax rates than smaller firms over the long-run. Our results, however, stand in contrast to much of the prior academic literature, as most studies find evidence suggesting large firms pay *more* taxes, not less. The inconsistency in results appears to be driven by the measurement horizon, as the association between firm size and taxes effectively vanishes when cash ETRs are estimated on an yearly basis. As such, our study offers a key insight into the inconsistency of findings in prior literature.

After ensuring that our primary findings are robust to different specifications, we turn our attention to explaining this effect. We find the downward trend in effective tax rates with respect to size cannot be explained by foreign operations, asset tangibility, R&D spending, capital structure, net operating loss carryforwards, or releases in the valuation allowance. Because firm size is highly correlated with profitability, we examine tax convexity as an explanation for the association between size and taxes, using a number of measures that capture the extent to which firms are able to achieve symmetric tax treatment of profits and losses. These results show that between 50 to 80 percent of the size effect is a result of the presence of losses. In subsequent tests we show that our measure of losses does not appear to be simply capturing general profitability. Thus, the effects of size on taxes appear to be most salient for firms facing convex tax functions, preventing them from fully utilizing the benefit of current and prior losses.

Our findings suggesting the association between firm size and taxes is potentially a result of tax convexity adds to prior literature by helping explain one of the most fundamental associations in the tax literature. They also have direct implications for future tax policy. While we do find results suggesting large firms pay lower tax rates, we show this is not a result of aggressive transfer pricing or offshoring activity as commonly depicted by tax advocacy groups and the media. Further, our results suggest that changes to the tax code that do not affect the tax treatment of losses are unlikely to affect differentials in effective tax rates with respect to size.

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Table I: **Sample selection.** Panel A presents firm-year observation counts in the construction of the base sample. The first row reports the number of firm-year observations for all U.S.-incorporated firms in Compustat for the period 1988 through 2017, excluding financial, utility, and quasi-governmental firms. The subsequent rows report the number of observations eliminated with the sequential application of each data requirement. The final row reports the number of firm-year observations in our base sample with all filters applied. Panel B presents sample attrition for cash ETRs measured at different horizons from our base sample presented in Panel A. A non-missing N-year cash ETR requires that the N-year sum of pretax income be positive and the N-year sum of cash taxes paid be non-negative. The number of observations eliminated due to these sequential requirements are reported in rows 2 and 3, respectively. The number of non-missing cash ETR observations at the 1, 5, and 10-year horizon are reported in the final row. Panel C reports the number of observations for 10-year and 1-year ETR measures across Fama-French 17 industry groupings in columns (1) and (3), respectively. Columns (2) and (4) represent the number of firm-year observations in any given industry as a percentage of total observations for each respective sample. Column (5) shows the fraction of observations in the 10-year versus the 1-year sample, by industry. Columns (6) and (7) present the mean market value of assets for firm-year observations in any given industry for each respective sample, and Column (8) presents the ratio of these values. Column (9) presents the total market value of assets for long-run ETRs as a percentage of the total market value of assets for firms in the 1-year sample, by industry.

Panel A: Firm-year sample	Obs.
Compustat sample	173,669
Less missing cash taxes paid	43,276
Less missing pretax income	5
Less missing operating income	241
Less book assets <$50 million	38,049
Less missing market value of equity	9,918
Less missing or negative sales	274
Firm-year observations	81,906

Panel B: Cash ETR sample	Observations		
	1-year	5-year	10-year
Firm-years with N consecutive years of data	81,906	50,351	28,362
Less non-positive N-year pretax income	21,115	10,666	4,321
Less negative N-year cash taxes paid	2,355	577	114
N-year cash ETR observations	58,436	39,108	23,927

Panel C: Comparing the 10-year and 1-year cash ETR samples

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Observations					Market value of assets ($M)			
	10-year		1-year			10-year	1-year		Fraction
Industry	Number	Percent	Number	Percent	(1)/(3)	Mean	Mean	(6)/(7)	represented
Food	1,216	5.1%	2,597	4.4%	0.47	15,688	10,708	1.47	0.69
Mining and Minerals	341	1.4%	744	1.3%	0.46	8,314	4,388	1.89	0.87
Oil	1,108	4.6%	2,787	4.8%	0.40	31,149	15,292	2.04	0.81
Textiles	728	3.0%	1,637	2.8%	0.44	4,137	2,472	1.67	0.74
Consumer Durables	786	3.3%	1,851	3.2%	0.42	2,925	1,829	1.60	0.68
Chemicals	807	3.4%	1,627	2.8%	0.50	9,559	7,040	1.36	0.67
Pharmaceuticals	766	3.2%	2,002	3.4%	0.38	53,078	25,681	2.07	0.79
Construction	1,371	5.7%	3,100	5.3%	0.44	7,476	4,268	1.75	0.77
Steel	453	1.9%	1,077	1.8%	0.42	3,397	2,307	1.47	0.62
Fabricated Products	352	1.5%	762	1.3%	0.46	3,980	2,266	1.76	0.81
Business Equipment	4,104	17.2%	9,122	15.6%	0.45	10,531	5,781	1.82	0.82
Automobiles	620	2.6%	1,327	2.3%	0.47	26,328	14,784	1.78	0.83
Transportation	1,427	6.0%	3,082	5.3%	0.46	14,172	8,547	1.66	0.77
Retail Stores	2,233	9.3%	5,397	9.2%	0.41	14,484	7,667	1.89	0.78
Other	7,615	31.8%	21,324	36.5%	0.36	13,970	7,265	1.92	0.69
All industries	23,927	100.0%	58,436	100.0%	0.41	14,285	7,811	1.83	0.75

Table II: **Cash ETR by size.** Panel A presents statistics of cash ETR at the 10-year, 7-year, 5-year, 3-year, and 1-year horizons. Statistics for the full sample are reported in the first four rows followed by the average cash ETR by size decile, as well as for the top 1% of firms. The penultimate (final) row reports the difference between the tenth decile (top 1%) and the first decile. Bootstrapped standard errors or t-statistics are reported to the right of each sample statistic. Size is defined as the market value of assets and size deciles are constructed annually. Panel B follows the same format as Panel A using a number of alternative specifications. Column (1) reports statistics for the tax preference measure of Henry and Sansing (2018) over a ten-year horizon. Column (2) reports statistics for 1-year cash ETRs for firm-year observations with non-missing 10-year cash ETRs. Columns (3)–(5) report statistics for 10-year cash ETR employing different measures of size. Finally, column (6) constructs 10-year cash ETR excluding special items from pretax income. In both panels, size bins are constructed annually.

Panel A: Varying time horizon

	(1)		(2)		(3)		(4)		(5)	
	10-year ETR	S.E.	7-year ETR	S.E.	5-year ETR	S.E.	3-year ETR	S.E.	1-year ETR	S.E.
Mean	0.351	0.003	0.343	0.003	0.336	0.002	0.322	0.002	0.295	0.002
Median	0.319	0.002	0.314	0.002	0.310	0.002	0.301	0.002	0.275	0.002
Std dev.	0.201	0.003	0.207	0.002	0.211	0.002	0.215	0.002	0.225	0.001
Obs	23,927		32,318		39,108		47,370		58,436	
Size Decile										
(Small) 1	0.414	0.010	0.403	0.008	0.392	0.008	0.351	0.006	0.301	0.005
2	0.392	0.009	0.371	0.008	0.359	0.007	0.335	0.006	0.294	0.005
3	0.384	0.009	0.369	0.007	0.354	0.006	0.334	0.005	0.297	0.004
4	0.377	0.009	0.360	0.007	0.357	0.006	0.340	0.005	0.295	0.004
5	0.347	0.007	0.350	0.006	0.344	0.005	0.331	0.005	0.298	0.004
6	0.342	0.007	0.333	0.006	0.333	0.005	0.324	0.005	0.297	0.004
7	0.325	0.007	0.319	0.006	0.313	0.005	0.310	0.004	0.293	0.004
8	0.317	0.006	0.326	0.006	0.320	0.005	0.310	0.004	0.290	0.004
9	0.327	0.009	0.317	0.007	0.310	0.006	0.306	0.005	0.295	0.004
(Large) 10	0.306	0.008	0.305	0.006	0.306	0.006	0.302	0.005	0.295	0.004
Top 1%	0.269	0.018	0.282	0.018	0.284	0.016	0.290	0.014	0.290	0.013
Difference		t-stat		t-stat		t-stat		t-stat		t-stat
(10)−(1)	-0.108	-8.27	-0.098	-9.29	-0.086	-8.68	-0.049	-5.92	-0.005	-0.79
Top 1%−(1)	-0.144	-6.73	-0.121	-6.05	-0.108	-6.19	-0.061	-4.00	-0.010	-0.73

Panel B: Selection effects and alternative measures

	(1)		(2)		(3)		(4)		(5)		(6)	
	Henry-Sansing 10-year		1-year ETR 10-year sample		Size measure: book assets		Size measure: sales		Size measure: market value equity		ETR before special items	
		S.E.		S.E.		S.E.		S.E.		S.E.		S.E.
Mean	0.123	0.016	0.301	0.002	0.351	0.003	0.351	0.003	0.351	0.003	0.295	0.003
Median	-0.057	0.012	0.279	0.002	0.319	0.002	0.319	0.002	0.319	0.002	0.281	0.003
Std dev.	0.930	0.016	0.203	0.002	0.201	0.003	0.201	0.003	0.201	0.003	0.169	0.003
Obs	25,445		20,106		23,927		23,927		23,927		21,601	
Size Decile												
(Small) 1	0.479	0.050	0.316	0.008	0.394	0.009	0.363	0.012	0.419	0.011	0.363	0.011
2	0.453	0.046	0.324	0.007	0.386	0.008	0.372	0.009	0.406	0.011	0.334	0.009
3	0.310	0.040	0.319	0.007	0.368	0.008	0.364	0.008	0.390	0.009	0.322	0.008
4	0.217	0.038	0.313	0.006	0.368	0.008	0.370	0.009	0.379	0.008	0.307	0.007
5	0.134	0.036	0.303	0.006	0.367	0.008	0.368	0.008	0.350	0.007	0.292	0.007
6	0.075	0.035	0.302	0.006	0.345	0.008	0.342	0.008	0.338	0.007	0.284	0.006
7	-0.010	0.041	0.293	0.006	0.318	0.007	0.335	0.008	0.326	0.006	0.281	0.007
8	-0.055	0.033	0.283	0.006	0.327	0.007	0.341	0.007	0.319	0.007	0.262	0.005
9	-0.108	0.031	0.293	0.007	0.330	0.008	0.345	0.009	0.321	0.008	0.263	0.006
(Large) 10	-0.196	0.036	0.285	0.006	0.318	0.009	0.318	0.008	0.295	0.007	0.255	0.007
Top 1%	-0.394	0.095	0.263	0.021	0.304	0.023	0.294	0.023	0.260	0.016	0.221	0.015
Difference		t-stat		t-stat		t-stat		t-stat		t-stat		t-stat
(10)−(1)	-0.674	-11.26	-0.031	-3.06	-0.077	-5.93	-0.044	-3.14	-0.123	-9.19	-0.108	-8.21
Top 1%−(1)	-0.873	-8.12	-0.053	-2.43	-0.090	-3.70	-0.069	-2.68	-0.159	-8.24	-0.142	-7.63

Table III: **Descriptive statistics.** This table reports descriptive statistics for the variables used in the baseline empirical analysis. With the exception of the five-year and one-year cash ETR variables, all statistics are for the sample with non-missing ten-year cash ETR. Variable definitions are provided in the appendix. Dollar value variables are reported in millions of dollars inflation adjusted to 2017.

	N	Mean	S.D.	Min	Q1	Median	Q3	Max
Market value of assets (MVA), 2017 dollars	23,927	11,393.72	37,472.13	43.60	600.09	1,838.07	6,491.58	607,477.00
log(MVA), 2017 dollars	23,927	7.65	1.73	3.78	6.40	7.52	8.78	13.32
Total book assets (AT), 2017 dollars	23,927	6,057.59	21,626.76	55.10	366.32	1,063.10	3,485.06	455,305.16
log(AT), 2017 dollars	23,927	7.13	1.63	4.01	5.90	6.97	8.16	13.03
Pretax income, 2017 dollars	23,927	556.88	2,311.06	-71.51	23.92	78.05	273.49	71,478.65
Cash taxes paid, 2017 dollars	23,927	160.96	741.70	-1.24	7.24	23.55	79.75	26,924.77
Ten-year cash ETR	23,927	0.35	0.20	0.00	0.24	0.32	0.39	1.00
Five-year cash ETR	39,108	0.34	0.21	0.00	0.21	0.31	0.39	1.00
One-year cash ETR	58,436	0.30	0.22	0.00	0.14	0.27	0.38	1.00
Book leverage	23,927	0.22	0.16	0.00	0.09	0.20	0.31	1.07
CapEx/Assets	21,186	0.07	0.05	0.00	0.03	0.05	0.08	0.50
Fraction foreign pretax income	23,927	0.21	0.26	0.00	0.00	0.09	0.38	1.00
Reporting foreign income [0,1]	23,927	0.63	0.48	0.00	0.00	1.00	1.00	1.00
R&D/Sales	23,927	0.03	0.05	0.00	0.00	0.00	0.03	0.66
TLCF/AT	17,325	0.07	0.19	0.00	0.00	0.01	0.07	6.96
Δ TLCF/AT	12,568	0.01	0.20	-2.90	0.00	0.00	0.03	6.22
Reporting TLCF [0,1]	23,927	0.59	0.49	0.00	0.00	1.00	1.00	1.00
Heitzman-Lester NOL benefit	22,860	0.02	0.03	0.00	0.00	0.01	0.02	0.35
Δ NOL benefit	15,065	-0.00	0.04	-0.35	-0.01	0.00	0.01	0.35
NOL benefit [0,1]	23,927	0.98	0.13	0.00	1.00	1.00	1.00	1.00
Drake-Hamilton-Lusch probability of VA release	12,986	0.10	0.05	0.02	0.05	0.11	0.13	0.76
Graham-Smith tax convexity	13,988	3.55	2.27	-1.80	1.83	3.46	5.17	11.81
Pretax income coefficient of variation	23,927	2.22	6.85	0.12	0.44	0.73	1.44	96.87
S.D. of pretax income	21,565	0.07	0.05	0.00	0.04	0.06	0.09	0.41
Frequency of loss-making	23,927	0.11	0.14	0.00	0.00	0.10	0.20	0.90
Fraction of losses	23,927	0.09	0.14	0.00	0.00	0.00	0.14	0.50
Pretax income/AT	21,565	0.10	0.07	-0.15	0.05	0.09	0.14	0.48

Table IV: **Correlation matrix.** This table reports pairwise correlations of variables used in the empirical analysis. Pearson correlations are reported above the diagonal, and Spearman (rank) correlations are reported below. Variable definitions are provided in the appendix.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1	log(MVA), 2017 dollars	1.00	0.97	0.59	0.61	-0.14	-0.11	-0.06	0.20	-0.07	0.24	0.28	0.20	-0.03	0.04	0.19	-0.14	0.03	-0.08	0.16	0.02	-0.05	-0.11	-0.20	-0.14	0.17
2	log(AT), 2017 dollars	0.97	1.00	0.57	0.59	-0.11	-0.09	-0.06	0.28	-0.08	0.25	0.27	0.12	0.00	0.05	0.23	-0.11	0.04	-0.06	0.18	0.11	-0.02	-0.16	-0.14	-0.08	-0.03
3	Pretax income (PI), 2017 dollars	0.95	0.90	1.00	0.97	-0.12	-0.08	-0.04	0.02	-0.04	0.12	0.12	0.17	-0.04	0.02	0.00	-0.08	0.01	-0.10	0.00	-0.09	-0.06	-0.04	-0.15	-0.13	0.21
4	Cash taxes paid, 2017 dollars	0.91	0.87	0.95	1.00	-0.05	-0.02	-0.01	0.03	-0.03	0.10	0.11	0.12	-0.05	0.03	0.00	-0.09	0.03	-0.15	-0.01	-0.09	-0.05	-0.05	-0.15	-0.12	0.20
5	Ten-year cash ETR	-0.18	-0.16	-0.19	0.05	1.00	0.58	0.33	0.01	-0.10	-0.08	-0.07	-0.14	0.08	0.23	-0.03	0.08	0.24	-0.02	0.05	0.05	0.45	0.13	0.33	0.50	-0.16
6	Five-year cash ETR	-0.13	-0.13	-0.07	0.10	0.76	1.00	0.42	-0.05	-0.06	-0.08	-0.07	-0.15	0.09	0.19	-0.06	0.07	0.20	-0.03	-0.07	-0.05	-0.02	0.00	0.06	0.11	-0.01
7	One-year cash ETR	-0.07	-0.09	-0.02	0.10	0.49	0.57	1.00	-0.05	-0.02	-0.04	-0.04	-0.11	-0.01	0.08	-0.08	-0.04	0.08	-0.02	-0.11	-0.07	-0.06	-0.03	-0.08	-0.06	0.04
8	Book leverage	0.26	0.35	0.18	0.17	-0.07	-0.11	-0.11	1.00	-0.01	0.04	0.05	-0.17	0.11	0.03	0.19	0.09	0.02	0.03	0.16	0.27	0.08	-0.10	0.11	0.13	-0.34
9	CapEx/Assets	-0.06	-0.08	0.00	-0.02	-0.01	0.01	0.04	0.00	1.00	-0.22	-0.29	-0.19	-0.09	-0.02	-0.22	-0.09	-0.02	-0.01	-0.30	-0.25	-0.04	0.01	-0.11	-0.11	0.15
10	Fraction foreign pretax income	0.29	0.30	0.20	0.16	-0.21	-0.21	-0.16	0.08	-0.28	1.00	0.62	0.35	0.30	0.00	0.42	0.27	-0.02	0.09	0.44	0.44	0.04	0.01	0.14	0.11	-0.20
11	Reporting foreign income [0,1]	0.29	0.28	0.22	0.19	-0.15	-0.14	-0.11	0.09	-0.28	0.84	1.00	0.30	0.18	-0.01	0.45	0.16	-0.03	0.14	0.45	0.34	0.03	0.01	0.09	0.07	-0.08
12	R&D/Sales	0.16	0.11	0.09	0.05	-0.23	-0.22	-0.16	-0.06	-0.21	0.52	0.46	1.00	0.09	-0.09	0.19	0.11	-0.13	0.06	0.27	0.15	0.06	0.22	0.10	0.07	0.07
13	TLCF/AT	0.15	0.21	0.02	0.00	-0.11	-0.17	-0.18	0.21	-0.24	0.54	0.45	0.29	1.00	0.42	0.29	0.94	0.34	0.05	0.33	0.36	0.15	0.12	0.31	0.30	-0.25
14	Δ TLCF/AT	0.09	0.12	0.04	0.09	0.14	0.06	0.00	0.09	-0.06	0.13	0.15	0.07	0.45	1.00	-0.01	0.35	0.94	0.00	-0.05	-0.06	0.05	-0.08	0.00	0.04	-0.03
15	Reporting TLCF [0,1]	0.21	0.25	0.10	0.07	-0.16	-0.18	-0.15	0.21	-0.26	0.48	0.45	0.26	0.79	0.27	1.00	0.18	-0.07	0.14	0.83	0.65	0.11	0.08	0.27	0.24	-0.32
16	Heitzman-Lester NOL benefit	-0.23	-0.19	-0.34	-0.36	-0.05	-0.12	-0.17	0.02	-0.14	0.33	0.26	0.23	0.54	0.27	0.21	1.00	0.32	0.08	0.25	0.32	0.18	0.15	0.36	0.35	-0.28
17	Δ NOL benefit	-0.03	0.00	-0.05	0.01	0.19	0.11	0.01	0.03	-0.04	0.00	0.01	-0.05	0.18	0.60	-0.03	0.41	1.00	-0.02	-0.11	-0.09	0.04	-0.12	-0.04	0.02	-0.03
18	NOL benefit [0,1]	-0.07	-0.05	-0.11	-0.12	-0.07	-0.08	-0.07	0.03	-0.04	0.12	0.14	0.08	0.12	0.04	0.14	0.19	-0.01	1.00	0.12	0.15	0.03	0.01	0.07	0.06	-0.17
19	D-H-L probability of VA release	0.18	0.18	0.04	0.02	-0.09	-0.18	-0.17	0.12	-0.33	0.48	0.44	0.32	0.74	0.18	0.79	0.22	-0.06	0.09	1.00	0.70	0.24	0.26	0.51	0.44	-0.30
20	Graham-Smith tax convexity	0.03	0.13	-0.11	-0.13	-0.09	-0.19	-0.18	0.28	-0.27	0.46	0.35	0.19	0.68	0.11	0.66	0.37	0.00	0.15	0.67	1.00	0.20	0.19	0.46	0.44	-0.57
21	PI coefficient of variation	-0.21	-0.16	-0.36	-0.35	0.08	-0.08	-0.12	0.07	-0.09	0.11	0.04	0.03	0.28	0.03	0.24	0.27	-0.04	0.14	0.38	0.47	1.00	0.25	0.45	0.58	-0.23
22	S.D. of pretax income	-0.16	-0.21	-0.18	-0.17	0.12	0.00	-0.02	-0.15	0.00	0.03	0.03	0.11	0.11	0.00	0.08	0.12	-0.04	0.00	0.28	0.18	0.57	1.00	0.46	0.45	0.13
23	Frequency of loss-making	-0.19	-0.12	-0.36	-0.34	0.12	-0.06	-0.14	0.10	-0.16	0.15	0.09	0.05	0.37	0.07	0.29	0.33	0.02	0.08	0.52	0.53	0.77	0.47	1.00	0.82	-0.49
24	Fraction of losses	-0.18	-0.11	-0.36	-0.33	0.14	-0.05	-0.14	0.11	-0.17	0.15	0.09	0.04	0.37	0.07	0.29	0.34	0.04	0.07	0.51	0.54	0.78	0.47	0.98	1.00	-0.47
25	Pretax income/AT	0.15	-0.02	0.35	0.34	-0.02	0.13	0.16	-0.35	0.21	-0.19	-0.09	0.03	-0.38	-0.10	-0.32	-0.40	-0.10	-0.14	-0.25	-0.59	-0.51	0.12	-0.57	-0.59	1.00

Table V: **Explaining cash ETRs.** This table reports regression results with the ten-year cash ETR as the dependent variable. Firm size, *log(MVA)*, is measured as the natural logarithm of the average market value of assets over the previous ten years. *Mean book leverage*, *Mean CAPX/AT*, *Mean fraction foreign income*, *Mean R&D/Sales*, and *Mean probability of VA release* are constructed as the average of the indicated variable over the previous ten-year period. The indicator *Foreign income* $[0, 1]$ takes the value 1 if the firm reports foreign pretax income in one or more of the previous ten years. The NOL benefit is the estimated unused value of NOLs as a fraction of book assets, constructed using the method of Heitzman and Lester (2021), where $\Delta TLCF$ is the ten-year change in this variable and the indicator *NOL benefit* $[0, 1]$ takes a value of 1 if the NOL benefit is non-zero and non-missing in one or more of the previous ten years. The probability of VA release is from Drake et al. (2020). See the appendix for additional details on construction of the variables. All specifications include unreported industry (Fama-French 17) and year fixed effects. Bootstrapped t-statistics are reported in parentheses. Statistical significance of the coefficient estimates at the 1, 5, and 10% levels are indicated by ***, **, and *, respectively.

	(1)	(2)	(3)	(4)	(5)
log(MVA)	-0.018***	-0.021***	-0.019***	-0.023***	-0.017***
	(-9.86)	(-11.47)	(-9.07)	(-9.82)	(-6.65)
Mean book leverage		0.027	0.020	0.040	-0.014
		(1.29)	(0.80)	(1.61)	(-0.47)
Mean CAPX/AT		-0.610***	-0.549***	-0.627***	-0.518***
		(-9.94)	(-7.77)	(-8.03)	(-6.15)
Mean fraction foreign income		0.094***	0.044**	0.066***	0.006
		(5.86)	(2.44)	(3.89)	(0.30)
Foreign income [0,1]		0.001	-0.002	0.007	-0.012
		(0.17)	(-0.21)	(0.84)	(-1.10)
Mean R&D/Sales		-0.295***	-0.191**	-0.136	-0.222**
		(-4.01)	(-2.07)	(-1.53)	(-1.97)
Δ TLCF			0.212***		
			(8.03)		
TLCF [0,1]			0.024***		
			(3.88)		
Δ NOL Benefit				1.428***	1.304***
				(11.67)	(10.17)
NOL Benefit [0,1]				0.006	-0.014
				(0.36)	(-1.35)
Mean Probability VA release					0.784***
					(6.43)
Constant	0.508***	0.585***	0.564***	0.550***	0.502***
	(27.74)	(25.52)	(20.92)	(17.73)	(14.85)
Observations	23,927	21,186	12,332	14,819	8,139
R-squared	0.057	0.096	0.138	0.160	0.184

Table VI: **Taxes and convexity.** This table reports regression results with the ten-year cash ETR as the dependent variable. Firm size, *log(MVA)*, is measured as the natural logarithm of the average market value of assets over the previous ten years. *Mean book leverage*, *Mean CAPX/AT*, *Mean fraction foreign income*, *Mean R&D/Sales*, and *Mean PI/AT* are constructed as the average of the indicated variable over the previous ten-year period. The indicator *Foreign income* $[0,1]$ takes the value 1 if the firm reports foreign pretax income in one or more of the previous ten years. The NOL benefit is the estimated unused value of NOLs as a fraction of book assets, constructed using the method of Heitzman and Lester (2021), where $\Delta TLCF$ is the ten-year change in this variable and the indicator *NOL benefit* $[0,1]$ takes a value of 1 if the NOL benefit is non-zero and non-missing in one or more of the previous ten years. *Graham-Smith convexity* is the estimated expected percentage tax savings from a five percent reduction in the volatility of taxable income from Graham and Smith (1999). *Coeff. of variation PI* is the absolute value of the ratio of the standard deviation of pretax income to the mean of pretax income over the past ten years. *S.D. PI/AT* is the standard deviation of the ratio of pretax income over lagged book assets. *Frequency of losses* is the fraction of the previous ten years in which annual pretax income is negative. *Magnitude of losses* is the sum of absolute losses over the sum of absolute losses and profits over the previous ten years, a quantity that ranges from 0 to 1 by construction. *Mean PI/AT* is the ten-year mean of the ratio of pretax income to book assets. See the appendix for additional details on construction of the variables. All specifications include unreported industry (Fama-French 17) and year fixed effects. Bootstrapped t-statistics are reported in parentheses. Statistical significance of the coefficient estimates at the 1, 5, and 10% levels are indicated by ***, **, and *, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
log(MVA)	-0.021***	-0.016***	-0.019***	-0.008***	-0.003*	-0.014***
	(-8.11)	(-7.63)	(-8.29)	(-3.79)	(-1.67)	(-6.04)
Mean book leverage	0.019	-0.032	0.058**	-0.071***	-0.137***	-0.070***
	(0.63)	(-1.46)	(2.43)	(-3.08)	(-6.48)	(-2.59)
Mean CAPX/AT	-0.598***	-0.595***	-0.712***	-0.542***	-0.486***	-0.476***
	(-6.92)	(-8.57)	(-9.11)	(-7.53)	(-6.68)	(-6.03)
Mean fraction foreign income	0.047**	0.061***	0.084***	0.040***	0.038***	0.031*
	(2.44)	(4.08)	(4.99)	(2.67)	(2.86)	(1.88)
Foreign income [0,1]	0.008	0.006	0.007	0.010	0.012*	0.012
	(0.88)	(0.79)	(0.91)	(1.29)	(1.67)	(1.50)
Mean R&D/Sales	-0.183*	-0.350***	-0.413***	-0.461***	-0.550***	-0.177**
	(-1.73)	(-4.59)	(-4.47)	(-5.76)	(-8.52)	(-2.13)
Δ NOL Benefit	1.458***	0.975***	1.334***	1.012***	0.631***	1.290***
	(11.16)	(8.90)	(11.54)	(9.27)	(6.21)	(11.03)
NOL Benefit [0,1]	-0.014	-0.003	0.001	-0.019	-0.027**	-0.053***
	(-0.86)	(-0.19)	(0.08)	(-1.40)	(-2.07)	(-3.42)
Graham-Smith convexity	0.008***					
	(4.05)					
Coeff variation PI		0.014***				
		(28.48)				
S.D. PI/AT			1.159***			
			(12.31)			
Frequency of losses				0.606***		
				(19.55)		
Magnitude of losses					0.904***	
					(29.25)	
Mean PI/AT						-0.643***
						(-11.14)
Constant	0.594***	0.547***	0.517***	0.467***	0.439***	0.663***
	(16.50)	(17.65)	(14.50)	(14.46)	(13.96)	(19.48)
Observations	12,140	14,819	14,819	14,819	14,819	14,819
R-squared	0.164	0.383	0.219	0.306	0.475	0.198

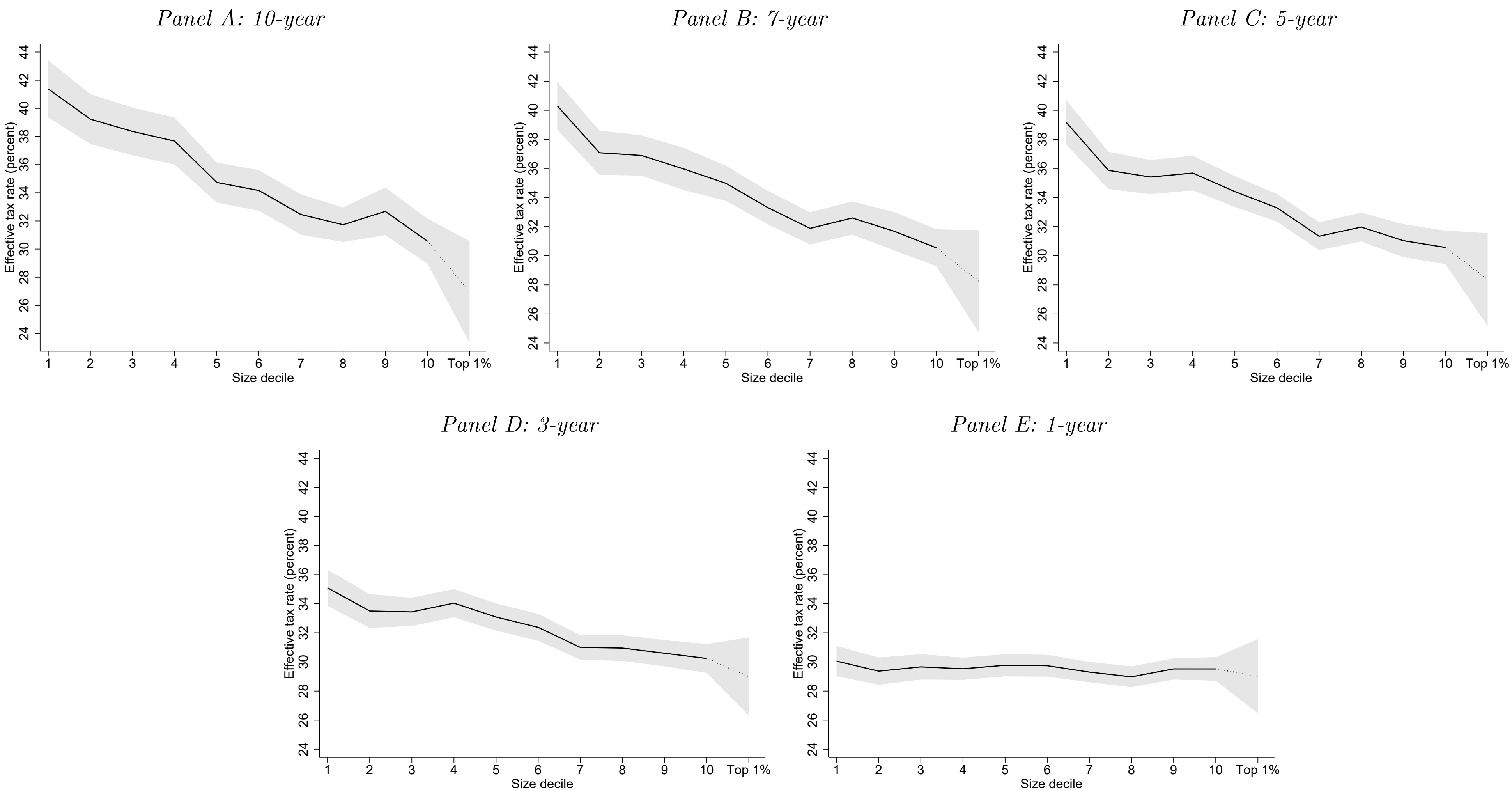

Fig. 1. **Cash ETR by size at varying horizons.** Each panel plots the average cash ETR within each size decile, as well as for the top 1% of firms, where the ETR is constructed over the horizon indicated. The bootstrapped 95% confidence intervals are shown by the shaded regions. Size is defined as the market value of assets and size deciles are constructed annually.

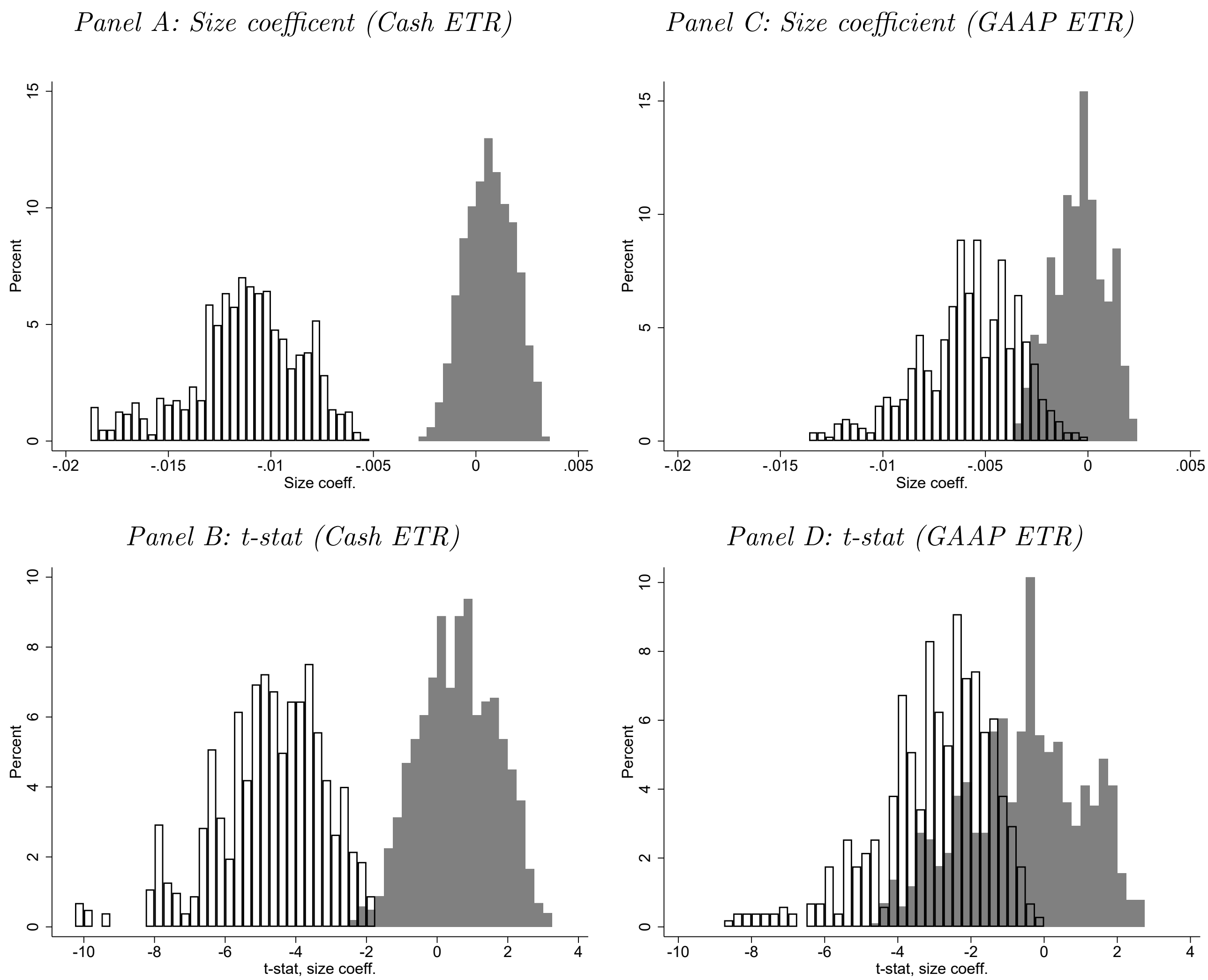

Fig. 2. **Histograms of size coefficient estimate in baseline ETR regression.** The figure presents the distribution of the size coefficients and corresponding t-statistics of a regression of ETR on size plus all possible combinations of ten control variables typically used in the literature. The panels show histograms for the size coefficient and corresponding t-statistics for the $2^{10} = 1,024$ regression specifications. The dependent variable is cash ETR (Panels A and B) or GAAP ETR (Panels C and D). Size is the log of market value of assets. Results using one-year ETRs are shown in solid gray. For comparison, the exercise is repeated using ten-year ETRs with the results reported with open bars. Consistent with Chen, Chen, Cheng, and Shevlin (2010) and Chyz, Leung, Li, and Rui (2013), the ten control variables considered are ROA (before special items), book leverage, TLCF indicator, change in TLCF over lagged assets, fraction foreign income over lagged assets, PP&E over lagged assets, intangible assets over lagged assets, equity income in earnings over lagged assets, market-to-book value of equity, and book tax difference. See Appendix A.2 of Chen et al. (2010) for details of variable construction. For the ten-year specifications, the ten-year mean of each control is used, with the exception of the change in TLCF to asset ratio, which is computed as the ten-year change, and the TLCF indicator, which is set to one if TLCF is non-zero in any of the previous ten years. All specifications include industry (Fama-French 17) and year fixed effects.

ETR by size in 1997, 2007, and 2017.

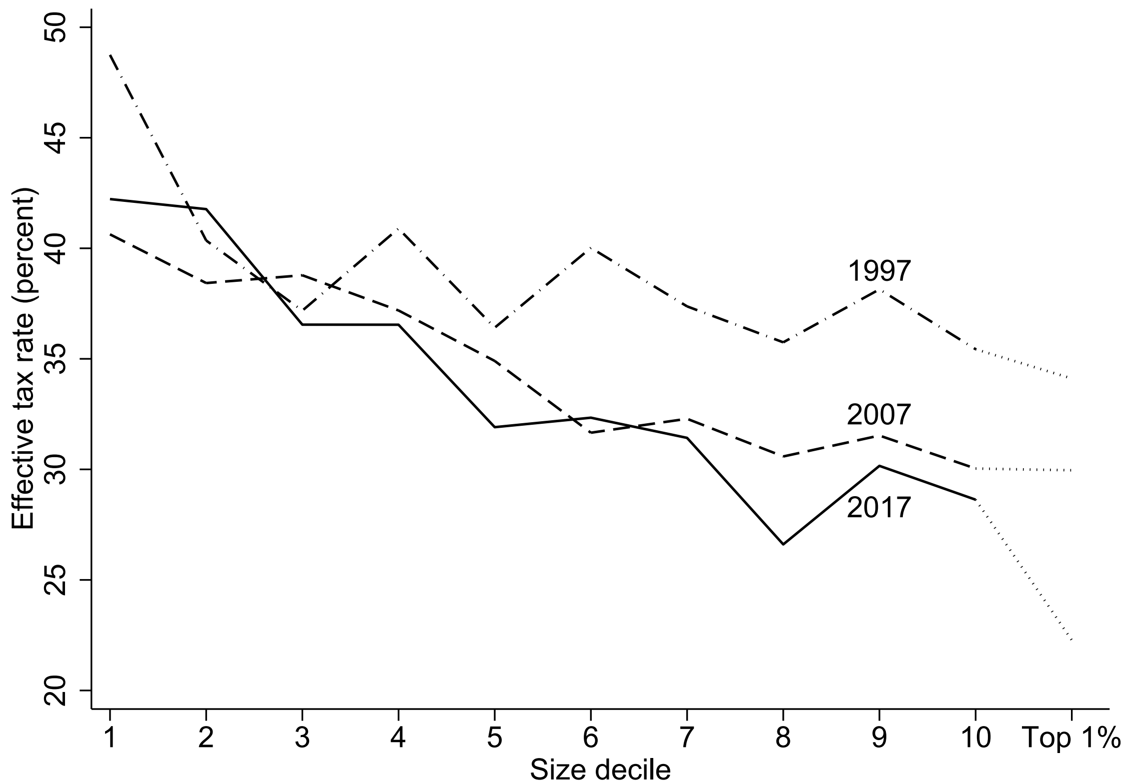

Fig. 3. **Effective tax rate by size in each decade.** This figure plots the average ten-year cash ETR within each size decile, as well as for the top 1% of firms, at three points in time. The dash-dotted line corresponds to the average ten-year rates in the year 1997, covering the decade 1988–1997. The dashed and solid lines are for years 2007 and 2017, covering the decades 1998–2007 and 2008–2017, respectively. Size is defined as the market value of assets and size deciles are constructed annually.

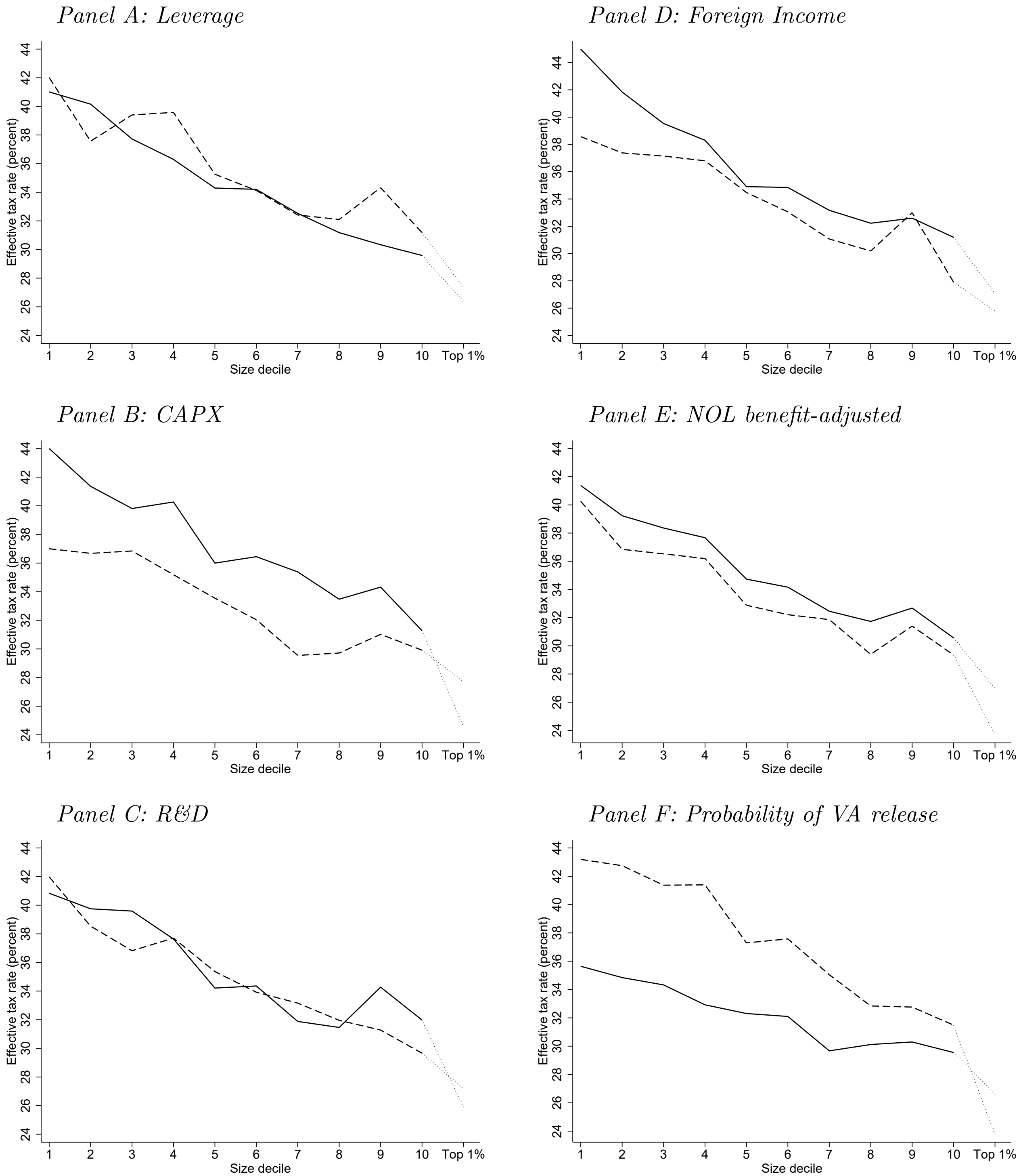

Fig. 4. **Subsample splits.** This figure reports average ten-year cash ETRs within each size decile, as well as for the top 1% of firms, for various subsample splits. For panels A (leverage), B (CAPX), C (R&D), and F (probability of VA release), firms with values of the indicated variables above (below) the full sample mean are shown by the dashed (solid) line. Capital expenditures are scaled by lagged assets and R&D is scaled by sales. Splits are done based on the ten-year average of the indicated variable, corresponding to the ten-year period used to measure the ETR. In Panel D, multinational firms (firms that report non-zero foreign income over the preceding ten-year period) are shown by the dashed line; the remaining domestic-only firms are shown by the solid line. In Panel E, ten-year cash ETRs adjusted for the change in the NOL benefit as measured by Heitzman and Lester (2021) are shown by the dashed line; the solid line shows the benchmark (i.e., unadjusted) ten-year cash ETRs. For all panels, size is defined as the market value of assets and size deciles are constructed annually. Additional details of the variables used to construct subsamples are provided in the appendix.

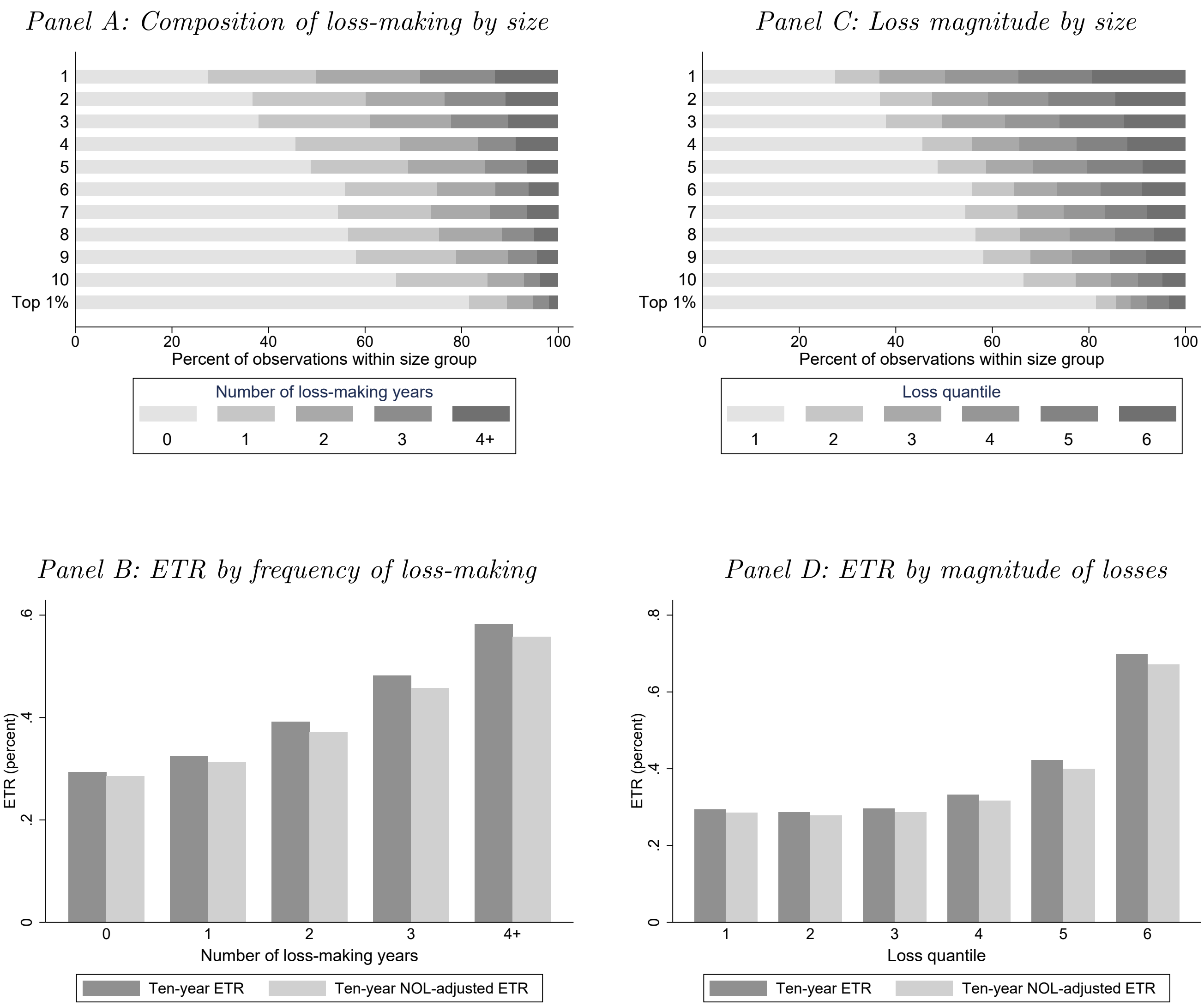

Fig. 5. **Composition of losses by size and ETR conditional on losses.** Panels A and C report the frequency and magnitude of losses by size, respectively. The frequency of loss is defined as the number of years the firm reports negative pretax income over the preceding ten-year period. The magnitude of losses is defined as the sum of absolute losses over the sum of absolute losses and profits over the previous ten years, a quantity that ranges from 0 to 1 by construction. See the appendix for additional details. Panels A and C reports the sample composition within each size decile, as well as the top 1 percent, based on these loss measures. For Panel C, firms with zero losses are assigned to the first quantile, which represents 49.8 percent of the entire sample. The remaining sample is divided into quintiles based on the magnitude of losses and assigned to quantiles 2–6. The bottom two panels report the ETR conditional on a given frequency of loss (Panel B) or quantile of loss magnitude (Panel D). The dark grey bar reports the ten-year cash ETR, and the light grey bar reports the ten-year cash ETR adjusted for the change in the Heitzman and Lester (2021) NOL benefit over the ten-year period. Size is defined as the market value of assets and size deciles are constructed annually.

Appendix: Variable Definitions

Variable	Definition
Market value of assets	Ten-year mean of: Total book assets (AT) plus market value of equity ($PRCC\_F \times CSHO$) minus book value of shareholders' equity (SEQ)
Total book assets	Ten-year mean of: AT
Pretax income	Ten-year mean of: PI
Cash taxes paid	Ten-year mean of: $TXPD$
N-year cash effective tax rate	Sum of cash taxes paid ($TXPD$) over the previous N years divided by the sum of pretax income (PI) over the same N-year period: $$\frac{\sum_{s=0}^{N-1} \text{TXPD}_{t-s}}{\sum_{s=0}^{N-1} \text{PI}_{t-s}} \quad (1)$$
Book leverage	Ten-year mean of: Sum of long-term debt ($DLTT$) and debt in current liabilities (DLC) divided by book assets (AT)
CapEx/Assets	Ten-year mean of: Capital expenditures ($CAPX$) divided by lagged book assets (AT)
Fraction foreign pretax income	Ten-year mean of: Absolute foreign income ($PIFO$) divided by absolute pretax income (PI); missing values of $PIFO$ are set to zero
Reporting foreign income [0,1]	Equals 1 if the (ten-year) fraction foreign pretax income is positive; 0 otherwise
R&D/Sales	Ten-year mean of: R&D expense (RDX) divided by sales ($SALE$); missing values of R&D are set to zero
TLCF/AT	Ratio of tax loss carryforwards ($TLCF$) to total book assets (AT); missing values are not replaced by zero
Δ TLCF/AT	Ten-year change in TLCF/AT
Reporting TLCF [0,1]	Equals 1 if firm reports non-zero, non-missing TLCF in one or more of the previous ten years; 0 otherwise
Heitzman-Lester NOL benefit	The estimated value of NOLs, as a fraction of book assets, using the approach of Heitzman and Lester (2021)
Δ NOL benefit	Ten-year change in the Heitzman-Lester NOL benefit
NOL benefit [0,1]	Equals 1 if the Lester-Heitzman NOL benefit is non-zero and non-missing in one or more of the previous ten years; 0 otherwise
Drake-Hamilton-Lusch (DHL) probability of VA release	The predicted probability of VA release estimated in Drake, Hamilton, and Lusch (2020)

Graham-Smith tax convexity	The estimated expected percentage tax savings from a five percent reduction in the volatility of taxable income from Graham and Smith (1999)
Pretax income coefficient of variation	The absolute value of the ratio of the standard deviation of pretax income (PI) to the mean of pretax income over the past ten years
S.D. of pretax income	The standard deviation of the ratio of pretax income (PI) over lagged book assets (AT)
Frequency of loss-making	The fraction of the previous ten years in which annual pretax income (PI) is negative
Magnitude of losses	The sum of absolute losses over the sum of absolute losses and profits over the previous ten years, a quantity that ranges from 0 to 1 by construction: $$\frac{\sum_{s=0}^{9} \lvert \mathbb{1}_{[PI_{t-s}<0]} PI_{t-s} \rvert}{\sum_{s=0}^{9} \lvert PI_{t-s} \rvert} \quad (2)$$
Pretax income/AT	The ten-year mean of: the ratio of pretax income (PI) to book assets (AT)
Henry-Sansing tax avoidance measure	The tax avoidance measure of Henry and Sansing (2018) using the previous ten years of data. Specifically, $100 \times AVOID_{t-9,t}/MVA_{t-9,t}$ where $AVOID_{t-9,t} = \sum_{s=0}^{9} TXPD_{t-s} - \Delta TXR_{t-s} - \tau_{t-s} PI_{t-s}$ and $MVA_{t-9,t}$ is the ten-year sum of the market value of assets. ΔTXR_t is the one-year change in the income tax refund, $TXPD$ is cash taxes paid, and PI is pretax income.
N-year cash ETR before special items	Sum of cash taxes paid ($TXPD$) over the previous N years divided by the sum of pretax income (PI) minus special items (SPI) over the same N-year period: $$\frac{\sum_{s=0}^{N-1} \text{TXPD}_{t-s}}{\sum_{s=0}^{N-1} (\text{PI}_{t-s} - \text{SPI}_{t-s})} \quad (3)$$