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# An evaluation of alternative measures of corporate tax rates ☆

George A. Plesko*

*Sloan School of Management, Massachusetts Institute of Technology, Cambridge, MA 02142, USA*

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## Abstract

This paper examines the ability of financial statement measures of average and marginal tax rates (MTR) to capture tax attributes utilizing firm-level tax and financial data. The results suggest commonly used average tax rate measures provide little insight about statutory tax burdens, and may introduce substantial bias into analyses of tax incidence. Financial statement-based proxies for MTR, particularly those based on simulation methods, are found to perform well in estimating current year tax rates. Both current year and present value MTR

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*Tel.: +1-617-253-2668; fax: +1-617-253-0603.
*E-mail address:* gplesko@mit.edu (G.A. Plesko).

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are found to be highly correlated with an easily constructed binary proxy of firms' tax status.


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## 1. Introduction

Numerous empirical studies have examined the role taxes have on corporations' decisions, such as organizational choice, investment decisions, financing mix, dividend policy, merger and acquisition activities, accounting choices, compensation decisions, and responses to political pressures.[1] In contrast to studies of individual taxation, where public-use micro data are available, firm-level tax return data are confidential. As a result, non-governmental researchers are usually forced to construct tax variables from financial statements,[2] leading to both a proliferation of suggested measures, and concerns about their accuracy. Gramlich (1992), Callihan (1994), Shackelford and Shevlin (2001), and Maydew (2001) identify tax rate measure refinement and improvement as important to furthering research.

Absent data on firms' tax return information, researchers develop measures from financial statements to capture these unobserved characteristics, and have been aided by a series of accounting standards (APB 11, SFAS 96, SFAS 109) designed to provide more information about differences between tax and financial income reporting. This paper evaluates commonly used tax measures by directly comparing financial statement to tax return-based tax rate constructs for a matched sample of tax and Compustat data.

The results show that financial statement-based average tax rate (ATR) measures, such as those used by the US Congress, Joint Committee on Taxation (1984), Porcano (1986), Shevlin (1990), Stickney and McGee (1982) and Zimmerman (1983) are not highly correlated with statutory tax burdens, and produce biased estimates of firms' tax reporting. The extent of the bias is shown to be exacerbated by other financial and demographic variables often used to examine corporate tax burdens. As dependent variables, the mismeasurement in ATR can be sufficient to lead to erroneous conclusions about the magnitude, and direction, of factors influencing statutory tax burdens.

Although financial statement based measures of taxable income and liability are the foundation of simulated marginal tax rates (MTR) (Shevlin, 1990; Graham, 1996b), these present value proxies perform substantially better in controlling for

[1] Overviews of tax research can be found in Slemrod (1990), Scholes and Wolfson (1992), Brealey and Myers (1996) Auerbach and Slemrod (1997) and Shackelford and Shevlin (2001).

[2] Exceptions include Altshuler and Auerbach (1990), Boynton et al. (1992), Collins et al. (1995), Collins and Shackelford (1997), Cordes and Sheffrin (1981, 1983), Lyon (1997), Lyon and Silverstein (1995), Mills (1998), Mills et al (1998), Omer et al. (2000), and Plesko (1994, 2000a).

current year MTR than their average tax counterparts, and are less sensitive to the inclusion of other variables in regression models. Both current and present value MTR are estimated to be highly correlated with each other, and with an easily constructed binary variable based on the presence of net operating losses (NOLs) and a firm's current income.

The next section of this paper provides a brief review of the differences between tax and GAAP measures of income and outlines some of the difficulties in reconciling the two. Section 3 presents ATR definitions in tax and financial reporting contexts, and is followed in Section 4 by a review of the econometric implications of measurement error. Section 5 describes the data used in this paper and the construction of the sample. Sections 6 and 7 analyze average and MTR measures commonly used in the literature. The final section summarizes the conclusions.

## 2. Financial versus tax reporting

Given that financial reporting objectives differ from those of the tax system, it follows that income calculated under each system will differ. Financial accounting recognizes that income and tax liability reported to US tax authorities in any given year can differ from the amount that would be paid were GAAP income used as the basis for taxation. GAAP have prescribed various ways to account for these differences. Under SFAS 109, firms report a total tax liability based upon current year financial reporting income, and delineate the portions currently owed and deferred due to differences in income and expense recognition between tax and financial accounting methods. There are two reasons why these differences occur. First, timing differences are caused by differences in revenue and expense recognition between the two reporting systems that should at some point reverse. In many cases, timing differences arise from the reporting requirements under each system, but in others the differences arise because GAAP allow managers discretion in determining the appropriate amounts to accrue while the tax system does not. An obvious example of such a difference is depreciation.

The second source of differences in the income measure arise when a particular income or expense accrued under one system will never be recognized under the other. Interest on municipal bonds and a portion of dividends received, for example, are generally excluded from taxable income but are considered income under GAAP. Such "permanent" differences never reverse, and are reflected in a firm's reconciliation of its "effective" tax rate to the statutory rate. While both temporary and permanent differences may persist over time, a predictable relation between financial and tax reporting might still exist as the underlying business activities are the same.

Since each system's reporting objectives differ there are also reasons to expect a weak relation between financial and tax reporting. First, the two sets of rules may lead to large differences that do not reverse in a predictable pattern, or are expected to reverse but in fact do not. For example, while earnings in foreign subsidiaries are consolidated into the parent under GAAP, these earnings are not recognized as taxable income until cash is actually transferred to the domestic parent. While considered a temporary difference, under the assumption the earnings will eventually be repatriated, tax planning would have such transfers deferred for as long as possible, or forever.

Second, while judgment is considered an important element of financial reporting, the way in which judgement is exercised need not be consistent across firms, even within an industry. Such differences in discretion could confound any analysis that relies on detecting cross-sectional relations between tax and financial results.

Three additional factors complicate the relation between the values reported in financial statements and those reported for tax purposes. First, the consolidated entities may differ. GAAP requires firms to file consolidated financial statements that include all operations in which the parent has at least a 50% interest. For tax purposes, consolidation is not permitted unless there is at least 80% ownership, and even then it is not required. As a result, consolidated financial statements may include any number of separate taxable entities.

The second complicating factor is timing. Financial and tax reporting appear to follow similar timetables: financial statements are required to be filed within 90 days of the end of a corporation's fiscal year (approximately March 30 for a calendar year corporation) and corporate tax returns are due the 15th day of the third month after the close of the fiscal year (March 15 for the same corporation). The SEC filing date and the release of information to shareholders is relatively fixed, however, while firms must have paid all of their expected tax liability by that date in order to avoid interest and/or penalties on any underpayment, payment will usually be made in the course of obtaining a 6 month extension to file. The actual tax return will be submitted at a much later date, as late as September 15 for a calendar year corporation. Given financial statements are prepared and released months before tax returns are filed, many tax-related items reported in the financial statements (e.g. the current tax expense) are estimates of the tax liability that will be reported later in the year, and subject to change during the months leading up to the tax filing.

Finally, the income amount and tax liability reported on the original tax return may not represent the firm's ultimate tax liability. This is especially true for larger firms, which are under continuous audit by the IRS. As filed, tax returns may be viewed as a "first offer" to the government, determined with the knowledge that many aspects of the return will be thoroughly examined and challenged. Further, the return as filed, even if accepted, can be retroactively affected if carrybacks are generated in future years.

## 3. Defining tax rates

"Effective tax rates," as generally defined and constructed, are measures of average, rather than marginal, tax burdens. The general terminology of an "effective tax rate" does not clearly distinguish ATR, defined as some measure of tax over some measure of income, from MTR, measured as the change in tax for a given change in income. While ATR and MTR measures are intended to capture differences in tax burdens across firms, the suggestion that there is, or should be, one "true" measure is misleading, as most analyses of tax burden (particularly the marginal tax burden) are specific to the particular set of circumstances being examined.

Even with tax return information, defining the ATR is not straightforward as the final income measure for a corporation is reached by calculating a number of intermediate income definitions. Based upon the difference between income and deductions, corporations first calculate net income (NI), conceptually equivalent to pretax book income, which may be positive or negative. However, income subject to tax (IST), the basis of a firm's tax liability, can differ from NI for two reasons. First, IST cannot be negative; firms with negative NI will have zero IST in the current year. Second, firms with positive NI are allowed two additional deductions: NOLs and special deductions. The NOL deduction allows firms carrying forward losses from prior years to deduct them against current year income; special deductions are generated by the dividends received deduction. IST will be the maximum of NI after these deductions or zero. Further complicating the tax liability determination is the Alternative Minimum Tax (AMT), which may produce different tax levels owed by firms with the same amount of NI or IST as calculated under the regular tax.

Tax return ATRs may differ from the maximum statutory rate applied to IST for two reasons. First, corporate tax rates are graduated, and income below a threshold ($75,000 for the year examined here) is taxed at a reduced marginal rate. Second, current or past activities of a firm may generate tax credits that reduce the amount of tax the firm pays in a given year.

To better understand which tax concepts are captured by financial statement measures, the analyses in this paper use two measures of firms' statutory ATRs. The first, TACNI, is defined as tax after credits divided by the tax return measure of NI: taxable income before NOL and special deductions. The second measure, TACIST defined as tax after credits divided by IST.

While the accounting literature has produced a proliferation of ATR measures based upon financial information, those most commonly used have been identified and tested by Omer et al. (1991), and are presented in Table 1, along with a recent measure used by Gupta and Newberry (1997). All of the measures rely on the current tax expense (either federal or total) as the basis for measuring tax liability. However, as pointed out by Omer et al., the measures of income used in the denominators can be divided into three categories. The first category of ATRs use pretax book income or a variant of pretax book income as the measure of income. This group consists of the JCT, Porcano, and Gupta and Newberry, with the latter having the broadest measure of income as it excludes interest payments. The second category consists of Zimmerman and uses operating cash flow. The final category, consisting of Stickney and McGee and Shevlin, attempts to mimic taxable income.

Omer et al. (1991) have previously documented the sensitivity of ETR estimates to the measure employed, and that estimates of firms' ETRs are not robust to the

Table 1
Definitions and descriptive statistics of average tax rate measures

| Variable | Definition | Mean | Std. dev. |
|---|---|---|---|
| TACNI | Tax after credits/net income before special deductions | 0.178 | 0.203 |
| TACIST | Tax after credits/income subject to tax | 0.316 | 0.313 |
| **Study** | **Measure of average tax rate** | **Mean** | **Std.dev.** |
| US Congress, Joint Committee on Taxation (1984) | Current federal and foreign tax expense/pretax book income minus (equity income (loss) from unconsolidated subsidiaries and income (loss) from extraordinary and discontinued operations) plus income (loss) from minority interests. (63 + 64)/((18 + 16 + 49)−55) | 0.413 | 0.413 |
| Porcano (1986) | Current Federal tax expense/pretax book income minus equity income (loss) from unconsolidated subsidiaries plus income (loss) from minority interests. 63/(18 + 63 + 49 + ((−1.0 × 48)−55)) | 0.386 | 0.404 |
| Zimmerman (1983) | Total tax expense minus change in deferred tax liability and ITC/operating cash flow (16–change in 35)/(12–41) | 0.181 | 0.357 |
| Shevlin (1987) | Total tax expense minus change in deferred tax liability/pretax book income minus (change in deferred tax liability/ statutory marginal tax rate) (16−change in 74)/(18 + 16 + 49–(change in 74/0.34)) | 0.353 | 0.341 |
| Stickney and McGee (1982) | Total tax expense minus deferred tax expense/pretax book income minus (deferred tax expense/statutory marginal tax rate) (16−50)/(18 + 16 + 49−(50/0.34)) | 0.337 | 0.345 |
| Gupta and Newberry (1997) | Current income tax expense/book income before interest and taxes (16−50)/(170−55−17 + 15) | 0.359 | 0.458 |

Sample size is 1,116.
*Sources*: Definitions were drawn from Omer et al. (1991, p.60), with the exception of Gupta and Newberry (1997).

measure chosen. Given the different focus of each category's definition of income, a priori we should expect the measures in this last category to be the most highly correlated with the tax return measures. This is consistent with the implicit assumptions of Shevlin (1987) and Graham (1996b) in that they use Shevlin's (1990) construct as the basis of simulations used to estimate present value MTRs. Other measures of the ATR should be less correlated with the tax return measure of the ATR by design, as the measure they use is intended to capture a different concept of income.[3]

[3] Shevlin (1999) describes several research contexts where financial statement-based measures are the relevant measures of firms' tax burdens. See also the conclusion to Section 6.

## 4. Implications of measurement error

The previous discussion raises concerns about possible measurement error in financial statement-based measures of statutory tax rates, and it is worth detailing the econometric implications of such error in empirical research. This topic has received substantial attention in other fields such as labor economics (where there is concern about the accuracy of survey response data) and environmental economics (where different monitoring systems yield different measures of pollution levels). The following discussion is based upon a series of papers by Angrist and Krueger (1999), Bound and Kruegar (1991), and Duncan and Hill (1985) which focused on the effects of measurement error in labor market survey data, and general statistical treatments by Fuller (1987), Greene (1998), and Griliches (1986).

Consider the univariate linear regression framework in which one wants to estimate the effect of one continuous variable ($x^*$) on another continuous variable ($y^*$) each measured without error.[4] The estimated model is

$$y_i^* = \beta_0 + \beta_1 x_i^* + \varepsilon_i, \tag{1}$$

where $\varepsilon_i$ is assumed to be identically independently distributed, $\mathrm{N}(0, \sigma_\varepsilon^2)$ with $\mathrm{cov}(x_i, \varepsilon_i) = 0$. Measurement error in an independent variable implies that rather than observing $x_i^*$, one observes

$$x_i = x_i^* + \upsilon_i, \tag{2}$$

where $\upsilon_i$ is assumed to be distributed $\mathrm{N}(0, \sigma_\upsilon^2)$ and uncorrelated with $y_i^*$, $x_i^*$, and $\varepsilon_i$. In this case, the error in the measurement of $x_i^*$ introduces a proportional "attenuation bias" on $\beta_1$ of $(1 - \lambda)$, where

$$\lambda = \frac{\sigma^2_{x_i^*}}{\sigma^2_{x_i^*} + \sigma^2_{\upsilon_i}}. \tag{3}$$

If $\upsilon_i$ is uncorrelated with $y_i^*$, $x_i^*$, and $\varepsilon_i$, $\lambda$ will be less than one and the estimated coefficients will be biased toward zero, with the magnitude of the effect being related to the variance of the error in measurement, $\sigma_\upsilon^2$. $\lambda$ is often referred to as the "reliability ratio" with higher values of $\lambda$ associated with less noise in the observed data. If data on both $x_i^*$ and $x_i$ are available, $\lambda$ can be estimated directly by regressing $x_i^*$ on $x_i$. Estimates of $\lambda$ can be used to adjust coefficients obtained from regressions using $x_i$ rather than $x_i^*$ because $\lambda$ represents the proportion of a change in the observed but mismeasured variable ($x_i$) that represents a change in the unobserved variable ($x_i^*$ ).

In the context of this paper, the absolute and relative abilities of various financial statement estimates ($\tau_{\text{financial}}$) to control for variations in firms' tax return-based

[4] Aigner (1973) addresses the issue of measurement error in a binary independent variable, the errors of which are by definition non-normal and correlated with the value of the mismeasured variable.

tax rates ($\tau_{\text{tax}}$) are estimated using the following model:

$$\tau_{\text{financial}} = \beta_0 + \beta_1 \tau_{\text{tax}} + \sum_{i=2}^{N} \beta_i X_i, \tag{4}$$

where $\hat{\beta}_1$ is the estimate of $\lambda$ as defined in Eq. (3). The inclusion of additional exogenous variables ($X_i$) allows an examination of the effect of other included explanatory variables on the estimate of $\hat{\beta}_1$.

There are four complications relevant to this setting. First, in multivariate regressions the attenuation bias will affect the coefficients on all of the independent variables to the extent the explanatory variables are correlated. Second, the results described above rely on the assumptions that $\upsilon_i$ is normally distributed and uncorrelated with $y_i^*$, $x_i^*$, and $\varepsilon_i$. If these assumptions are violated, $\lambda$ may take on values greater than one. Third, panel data models—a frequent setting for the analysis of corporate behavior - may exacerbate the attenuation bias depending on the degree of serial correlation in $x_i^*$ compared to that in $\upsilon_i$.

The fourth complication concerns measurement error in a dependent variable. If there is measurement error ($\mu_i$) in the dependent variable, $y_i$, but it is distributed $N(0, \sigma_\mu^2)$, and uncorrelated with the "true" value, ($y^*$), the independent variables ($x_i^*$), and the error ($\varepsilon_i$), then the estimated coefficients of the explanatory variables will not be biased, but will have higher standard errors. If these assumptions are violated, then coefficient estimates will be biased (either upward or downward) and the bias in the coefficients will equal the coefficients of a regression on the measurement error ($\mu_i$) of the explanatory variables.

The empirical implications of measurement error can be significant. Topel (1991) concludes that inconsistencies in job tenure responses in the Panel Study of Income Dynamics (PSID) are so severe that reasonable parameter estimates cannot be obtained. Klepper et al. (1993) show how measurement error may not only lead to erroneous conclusions of the magnitude and significance of the mismeasured variable, but also demonstrate the broader effects measurement error in any independent variable can have on the signs and significance of other explanatory variables. They conclude that statistical inferences will be most severely affected by "measurement error in regressions that focus on variables with relatively small explanatory powers and that are correlated with the mismeasured variables."

## 5. Data and methodology

I use a matched sample of firms' financial statement and tax return data for 1992. A cross-section is chosen for three reasons. First, much of the use of tax rates in the literature is in cross-sectional settings. Second, by using a single year, I avoid the potentially complicating factors of tax law changes. While 1992 is not the most recent year available, it is the most recent year free of significant corporate tax law changes and the accompanying transitions of previous changes, as occurred during

1990, 1991, and 1993.[5] Finally, the MTR calculations for Section 7 required a focus on a single year to make the modeling effort tractable.

To construct the sample, I begin with the Internal Revenue Service's Statistics of Income's (SOI) corporation file, containing tax return information for 84,213 firms.[6] Data are recorded as filed, and validated for accuracy, but do not reflect any subsequent amendments or audit adjustments. Firms filing 1120-A, the corporate short form, as well as pass-through entities, such as subchapter S corporations, REITs and RICs were dropped, leaving approximately 53,868 tax return records.

To obtain financial statement information, firms with sufficient data to construct all of the ATR measures were drawn from Compustat. While Compustat includes a field for the firms' employer identification number (EIN), needed to match the financial statements to the tax returns, it is not collected for all firms. To expand the potential sample size, other sources of data containing both CUSIP numbers and EIN information were obtained, primarily from filings of information reports associated with employee benefit plans (Form 5500), which are publicly available. Firms with duplicate or contradictory EINs or CUSIPs were individually examined to correct for inconsistencies and errors. This file was then merged, by CUSIP, to the Compustat records with missing EINs. This resulting file was then merged, by EIN, to the corporate returns file. Non-matched firms were deleted, as were firms with missing or zero assets, yielding 7,734 observations.

Non-consolidated members of controlled groups were deleted to minimize consolidation differences, reducing the sample size to 4,484.[7] To reduce other effects of consolidation, and focus on accounting differences, the values of total assets and shareholder's equity reported on the tax return's balance sheet were compared to those reported in the financial statements. The balance sheet of the tax return (Schedule L) should reflect the assets and liabilities of the tax filing entity, regardless of GAAP consolidation. If the difference between the two values exceeded 0.005 of the smaller value the record was deleted, eliminating 3,271 firms.

The tax return file provides only limited information about firms' foreign operations. To address the effects of financially consolidated foreign source income that is not repatriated, firms indicating ownership in a controlled foreign corporation were deleted. The final data set contained 1,116 observations. Additional observations are deleted later in the context of specific tests if data are not available for all of the measures.

Summary statistics of the ATR sample are reported in Table 1. Following Omer et al. (1991) tax rates are windsorized to fall within the interval $(-1, +1)$.[8]

[5] U.S. Treasury (1999) reports the difference between aggregate pretax book income and taxable income "has clearly been growing since 1992 (p. 32)" suggesting that compared to other years, using 1992 should increase the correlation between financial and tax measures.

[6] The SOI sample is stratified by assets and income to represent the universe of corporation returns for the year. A description of the sampling methodology can be found in U.S. Internal Revenue Service (1995).

[7] See Dworin (1985) and Manzon and Plesko (1996, 2002) for discussions of consolidation issues.

[8] Approximately 2% of the financial statement-based tax rates fell outside this range. Less than 1% of the tax return measures were outside this range. Neither windsorizing nor exclusion of these firms from the

The mean ATR based upon the tax return definition of NI, TACNI, is 0.178 and increases to 0.316 for TACIST. This increase is not surprising, as the denominator of TACIST is constrained to be non-negative and firms with positive tax and zero income are assigned an ATR of one. The six financial statement-based measures display a wide range of mean values, from a low of 0.181 for Zimmerman to a high of 0.413 for the measure used by the JCT. Very few firms have negative ATRs under any of the measures, with Zimmerman's measure showing the highest proportion of zero or very low ATRs due to his use of operating cash flows in the denominator.[9]

With the exception of Zimmerman's measure, the hypothesis that the mean difference between the financial statement measure of the ATR and TACNI is zero cannot be accepted at any reasonable level of significance (probability is zero to four decimal points). With respect to TACIST, we reject the hypothesis of a zero mean difference at at least the 10% level with the exception of Stickney and McGee. Based on Shapiro-Wilk tests, the hypotheses that the differences between either of the tax return-based measures and any of the other measures are normally distributed is also rejected at any measurable level of significance.

## 6. The effects of measurement error in ATR

The first two columns in Panel A of Table 2 report the correlation coefficients ($\rho$) and the values of $\hat{\beta}_1$, the reliability ratio obtained from a univariate regression of Eq. (4) of TACNI on each of the financial statement-based measures. Consistent with the expectation that measurement error will bias a coefficient toward zero, the estimated $\beta$'s are all less than one and range from a low of 0.307 (Zimmerman) to a high of 0.673 (Gupta and Newberry). That Gupta and Newberry's measure has such a high estimated coefficient is surprising given their definition of income is the broadest, and least focused on capturing taxable income. These results imply that estimated regression coefficients for ATRs are understated by a factor ($1/\lambda$) of 1.49 (Gupta and Newberry) to 3.26 (Zimmerman) when compared to the rate reported on tax returns. To place these values in perspective, all of these estimates show greater bias than those variables of concern to labor economists. For example, Angrist and Krueger (1999) report cross-sectional $\lambda$s of wages and hours reported in the Current Population Survey of 0.77 and 0.87, respectively.

(*footnote continued*)
sample has a significant effect on any of the results or conclusions presented in this paper. Additional sensitivity tests, such as deleting firms with NOL carryforwards or restricting the range of values to (0, 0.34) were also carried out with no effect on the results except as noted later.

[9] Discussions of the sources and extent of differences in income reported on tax returns and financial statements can be found in U.S. Treasury (1999), Plesko (2000a, b), and Manzon and Plesko (2002). Sullivan (2000) and Hanlon and Shevlin (2002) focus on the role of non-qualified stock options in distorting the estimates of both taxes paid, and inferences of taxable income derived from financial statements. Consistent with the observation that different ATR measures attempt to capture different concepts of income, the results of Plesko (2000a) suggest measurement problems are more pronounced in the income numbers of these ratios than in tax liabilities.

Table 2
Estimated reliability ratios of average tax rate measures

| Measure | $\rho$ | Univariate $\beta$ | Bivariate $\beta$ | Multivariate $\beta$ |
|---|---|---|---|---|
| *Panel A. Tax measure: tax after credits/net income (TACNI)* | | | | |
| Stickney and McGee (1982) | 0.325 | 0.550(0.075) | 0.381(0.069) | 0.284(0.126) |
| JCT (1984) | 0.249 | 0.506 (0.076) | 0.315(0.067) | 0.077(0.106) |
| Zimmerman (1983) | 0.175 | 0.307(0.050) | 0.170(0.050) | 0.247(0.064) |
| Porcano (1986) | 0.230 | 0.457(0.074) | 0.307(0.069) | 0.085(0.110) |
| Shevlin (1987) | 0.280 | 0.468(0.064) | 0.329(0.059) | 0.123(0.104) |
| Gupta and Newberry (1997) | 0.299 | 0.673(0.082) | 0.495(0.075) | 0.432(0.116) |
| *Panel B. Tax measure: tax after credits/income subject to tax (TACIST)* | | | | |
| Stickney and McGee (1982) | 0.226 | 0.249(0.039) | 0.172(0.040) | 0.280(0.053) |
| JCT (1984) | 0.205 | 0.271(0.044) | 0.187(0.044) | 0.243(0.059) |
| Zimmerman (1983) | 0.060 | 0.068(0.035) | 0.006(0.035) | 0.046(0.026) |
| Porcano (1986) | 0.188 | 0.242(0.045) | 0.175(0.047) | 0.276(0.062) |
| Shevlin (1987) | 0.171 | 0.185(0.036) | 0.121(0.036) | 0.192(0.039) |
| Gupta and Newberry (1997) | 0.154 | 0.224(0.050) | 0.139(0.051) | 0.250(0.073) |

*Notes*: $\rho$ is the correlation coefficient between each financial statement measure and the tax-return measure of the average tax rate. The $\beta$s were estimated from variants of the following equation of financial statement estimates of tax rates ($\tau_{\text{financial}}$) and tax return-based tax rates ($\tau_{\text{tax}}$):

$$\tau_{\text{financial}} = \beta_0 + \beta_1 \tau_{\text{tax}} + \sum_{i=2}^{N} \beta_i X_i.$$

The univariate $\beta$ is the estimated coefficient from a regression of the tax return-based measure on the financial statement measure. Bivariate $\beta$ regressions include the log of assets as an additional explanatory variable. In the multivariate regressions, the additional covariates are log of assets, capital intensity (net PPE/total assets), leverage (long-term debt/total assets), NOL (a binary variable equal to one if the firm reports net operating loss carryforwards) and industry controls (eight one-digit SIC code dummy variables). Sample sizes are 1,116 for the univariate and bivariate regressions, 635 for the multivariate. Standard errors are in parentheses.

The difficulty in estimating a tax return-based ATR from financial statement information becomes apparent in Fig. 1 where the measure of Stickney and McGee, which has the highest correlation coefficient, is plotted against TACNI and TACIST. While both variables show a clustering around zero and the statutory maximum rate of 0.34, there is substantial variation in the estimated tax rates of firms which report either a zero tax rate on their tax return (before or after credits), or the statutory rate. In these cases, financial statement-based measures incorrectly assign a range of values to firms at the minimum and maximum tax rates, creating greater variation in tax rates than observed on tax returns.

Most empirical settings are not univariate, and other variables included in empirical models may be correlated with the measurement error, reducing the reliability of the coefficient on the tax variable. The third column of Table 2 shows the effects on the $\beta$s of adding ln(Assets) as an additional variable, with all coefficient estimates falling at least 25%. The final column presents the estimates of $\beta$ when

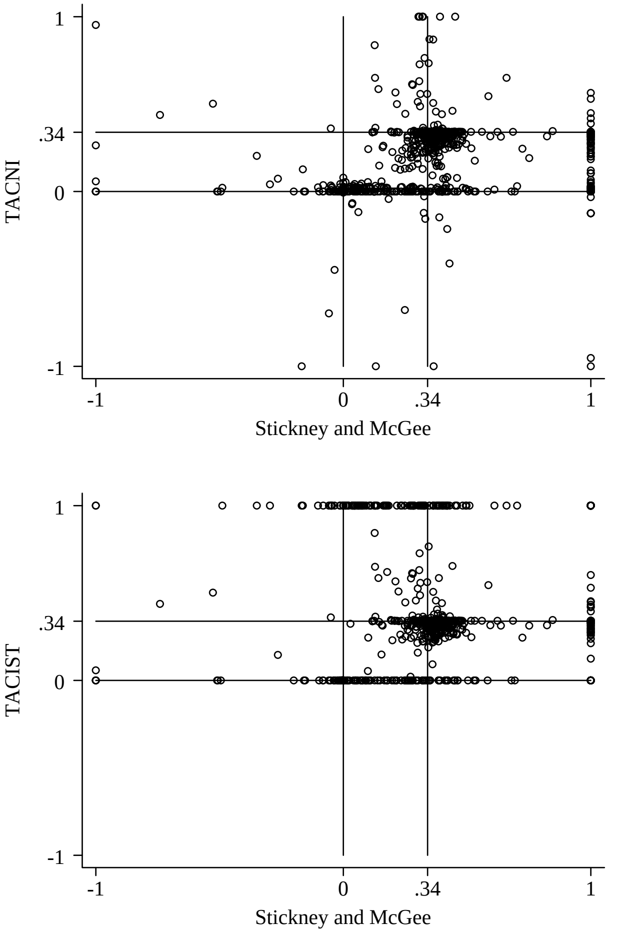


Fig. 1. Tax return versus financial statement measures of ATR.

additional explanatory variables are included,[10] and provides estimates of the bias in the ATR measures in empirical settings using the same explanatory variables. In all cases the reliability of the ATR measures fall and none exceed 0.500, although Gupta and Newberry's has both the highest estimated $\lambda$ and the greatest stability across specifications. Two of the measures, JCT and Porcano, have estimates of $\lambda$ below 0.100.

Panel B of Table 2 reports the results of similar estimation using TACIST as the benchmark. For all ATR measures the univariate and bivariate estimates of $\lambda$ are less

[10] In the multivariate regressions, the additional covariates are ln(Assets), capital intensity (net PPE/total assets), leverage (long-term debt/total assets), a binary variable equal to one if the firm reports NOL carryforwards, and eight one-digit SIC code dummy variables.

than those for TACNI. In the multivariate setting, four of the six ATR measures have essentially the same or higher estimates of $\lambda$ than for TACNI, with Zimmerman and Gupta and Newberry's performing worse.[11]

As discussed earlier, the existence of consolidation differences and foreign operations are considered to be among the most significant factors in the divergence between tax and financial reporting. While firms with ownership in controlled foreign corporations have been excluded, consolidated returns were included so long as they satisfied other restrictions to ensure consolidation was the same for tax and financial purposes. Consolidation, however, is likely to be associated with firm size, and reporting of consolidated operations for financial purposes may be less restrictive than tax. Tax rules for acquired NOLs, for example, restrict their use across entities within the corporation, restrictions which may not be apparent in financial reporting. To test the sensitivity of these results to the sample selection process, and in particular the possibility that consolidation differences influence the empirical relationships, the 868 consolidated returns were dropped and the regressions of Table 2 were re-estimated. While most of the estimated $\beta$s are larger within this more restrictive sample, all of the multivariate estimates are less than 0.600.

While the previous discussion focused on quantifying the bias in ATR measures when used as explanatory variables, other studies have sought to determine whether there are systematic differences in ATRs across firms of various characteristics, such as size, and what factors might be responsible for those differences. In some cases, these tests are performed via regression (e.g., Shevlin and Porter, 1992; Gupta and Newberry, 1997), while in others firms are grouped by a set of characteristics (such as assets or sales) and tests are performed as to whether ATRs are statistically different across groups (e.g., Zimmerman, 1983; Porcano, 1986; Kern and Morris, 1992). In these later cases, although regression analysis was not used in the original study, the test of means across different groupings could have been performed using a regression model with binary explanatory variables representing each characteristic. In such a setting the statistical significance of each regression coefficient becomes a test of differences in means.

Regardless of the original approach taken to analyze differences in measured ATRs, any inferences about statutory tax burdens depend upon the assumption that ATRs are measured correctly, or that any error in measurement is random, normal, and uncorrelated with the explanatory variable(s). Given the errors in the measured ATRs have already been shown to be non-normal, what remains to be determined are the effects these errors could have in an empirical setting.

To illustrate the implications of measurement error in the dependent variable, I estimate a simple model to explain variations in the ATR measure suggested by Stickney and McGee, one of the two measures attempting to capture tax return

[11] Constraining the financial statement ATRs to the (0, 0.34) interval generally increases the coefficient estimates of TACIST closer to those reported for TACNI. Univariate coefficients under this constraint range from 0.263 (Zimmerman) to 0.665 (Stickney and McGee).

Table 3
Factors affecting measurement error in average tax rate measures. This table reports the effects of measurement error in the dependent variable on coefficient estimates

| Dependent variable | Intercept | ln(*Assets*) | Capital intensity | Leverage | Adj $R^2$ |
|---|---|---|---|---|---|
| Stickney and McGee | $0.059^{**}$(0.028) | $0.072^{***}$(0.006) | $-0.199^{***}$(0.036) | $-0.001^{*}$(0.000) | 0.156 |
| Measurement error (Stickney and McGee—TACIST) | $-0.074^{**}$(0.034) | $0.041^{***}$(0.008) | $-0.340^{***}$(0.048) | 0.000 (0.000) | 0.072 |
| TACIST | $0.133^{***}$(0.027) | $0.031^{***}$(0.005) | $0.141^{***}$(0.037) | $-0.001^{*}$(0.000) | 0.048 |

The first row reports the coefficients of a regression on the measure of average tax rates proposed by Stickney and McGee (1982) taking the following form:

$$\mathrm{ATR}_i^{\mathrm{SM}} = \alpha + \beta_1 \ln(\mathrm{Assets}_i) + \beta_2(\mathrm{Capital\ intensity}_i) + \beta_3(\mathrm{Leverage}_i).$$

The second row reports the coefficients of a regression of the same independent variables on the measurement error of the ATR error in using TACIST as a base. The final row provides coefficient estimates for the variable measured without error. Robust standard errors in parentheses. Significance levels: $0.10^{*}$, $0.05^{**}$, $0.01^{***}$ Sample size is 1,084.

information, and the ATR measure with the highest correlation to TACIST:

$$\mathrm{ATR}_i^{\mathrm{SM}} = \alpha + \beta_1 \ln(\mathrm{Assests}_i) + \beta_2(\mathrm{Capital\ intensity}_i) + \beta_3(\mathrm{Leverage}_i). \tag{5}$$

The choice of explanatory variables is based on factors considered by Stickney and McGee (1982) and Gupta and Newberry (1997). Results of the estimation are reported in the first line of Table 3. With the exception of leverage, all of the variables are statistically significant at at least 5%, with leverage significant at 0.102. Further, the signs are the same as reported by Gupta and Newberry (1997), though their sample was restricted to firms without NOLs—a restriction not imposed here.

The extent of bias introduced by correlated measurement error is shown in line 2 of Table 3, which presents the results of regressing the same explanatory variables on the calculated measurement error in $\mathrm{ATR}^{\mathrm{SM}}$. As in line 1, all of the variables with the exception of leverage are statistically significant, with economically large coefficients representing the extent to which regression coefficients in line 1 are biased. Line 3 of Table 3 shows the results of a regression of the explanatory variables on the correctly measured variable, TACIST. The coefficients differ from those in line 1 by the amount of the bias shown in line 2. For ln(Assets), measurement error leads to a coefficient more than twice the value one would obtain using the tax return data. The absolute value of the bias of the capital intensity coefficient is greater than the size of the originally estimated coefficient, and not only affects the estimate of its magnitude, but also its sign.

These results suggest financial statement-based ATR are not very informative in inferring federal statutory tax burdens even for those measures designed to capture the tax return (e.g. Shevlin, 1990). In addition, the interpretation of any results based upon these measures (whether one is examining the sources of variation within a measure or the measure is used as an explanatory variables in the analysis of another issue) must be done with caution. In cases where researchers are trying to control for firms' statutory tax burden, measurement error affects not only the coefficient of the tax proxy (it will be biased toward zero), but also the coefficients of any other variables included in the regression—bias that may be magnified by the use of panel data. The results of Table 2 suggest a downward bias on tax coefficients and imply that publicly available data will understate the effects of taxes on firm behavior.

Given tax and financial reporting are distinct concepts, even within the firm, the lack of a strong relation between the two may not matter in some settings. While we would expect behavioral reactions to taxes to be based upon firm's actual tax status rather than that reported in financial statements, there may be aspects of behavior primarily driven by financial reporting, and separable from their tax reporting. If tax and financial reporting are essentially distinct, and the link between tax reporting and financial statements weak, there may not be a trade-off between tax strategies and financial reporting except in extreme cases where a specific accounting treatment is required for both (e.g. LIFO conformity). Under these circumstances, tax minimizing decisions may not in practice have significant financial reporting consequences. Conversely, in these cases, financial statements will shed little light on the influence of tax factors on behavior, and provide little evidence of tax motivations.

Financial reporting of taxes can matter even if that reporting is separate or only weakly associated with tax reports if managers use the tax numbers in financial statements to make corporate decisions. Such behavior would eliminate the errors-in-variables problem as financial statement values, rather than those reported on the tax return, would be the correct variables to use, even if this reporting did not necessarily reflect any real response to the tax system. For example, Phillips (2000) examines financial statement ATRs when compensation is based upon these same values. In this context, the underlying tax return information is not relevant since all actions are based upon reported financial statement information.

## 7. Measures of MTR

In most cases where research is concerned with the effects of taxes on firms' behavior it is the marginal, not the average, tax rate one wants to control for as the marginal rate reflects the change in tax associated with any particular decision. Almost by definition, the MTR is context specific, and may vary within a firm by the decision being considered.[12] Even if the context of the MTR is clearly defined, the MTR itself may not be. While there are three distinct measures of the MTR related to any activity, this paper focuses on the "last-dollar" MTR, which represents the amount of tax paid (saved) on the last dollar of income earned (deduction taken).

[12] For example, the marginal tax savings from additional depreciation will depend on whether the firm is affected, or close to being affected, by the AMT. For a firm on the AMT, the tax savings from additional interest deductions can exceed those from depreciation. For any taxable firm, interest received will be subject to a different tax rate than dividends received, due to the dividends received deduction.

For example, in capital structure decisions the last-dollar MTR measures the decrease in taxes due to the last dollar of interest payment deducted.[13]

Although there have been some estimates of MTRs from tax returns, researchers have primarily relied on estimates of firms' MTR based upon data reported in financial statements.[14] Shevlin (1987, 1990), develops and uses the financial statement-based measure of taxable income from his ATR measure to estimate the pattern of income and tax liabilities arising from variations in income over time. This methodology was extended by Graham (1996a, b) in the context of determining the tax savings from capital structure choices. Manzon (1994) takes a simpler approach, and assumes profitable firms face the statutory maximum rate, but that those with losses face a reduced tax rate, based upon the time horizon over which the loss is expected to reverse. Rather than perform extensive simulations, as done by Shevlin and Graham, Manzon estimates the number of years it would take the firm to use up all of its NOL carryforwards, and uses that value to discount the tax rate.[15]

The tax measures proposed by Shevlin, Manzon, and Graham attempt to measure the dynamic aspects of the tax code by calculating the effect on taxes over a period longer than one year.[16] In contrast, this paper uses the current year last dollar MTR as a benchmark. As a result, unless current year and present value tax rates are highly correlated, the tax return-based current year MTR used in this paper (CYMTR) is not the appropriate benchmark to assess the various present value proxies. However, given the persistence of firms' tax status reported by Altshuler and Auerbach (1990) and Graham (1996a, b), such correlation seems to be a reasonable assumption.[17]

Estimates of firms' CYMTRs were created by a calculator built for the 1992 SOI corporate file. For each firm, approximately 60 data items from the tax return were used in the calculations. These items were taken from Form 1120 (the corporate return) and its schedules, Form 3800 (General Business Credit including Foreign Tax Credit information for the purposes of calculating credit limitations), and Form 4626, the AMT, including the calculation of the Environmental Tax. The list of tax return variables is provided in Table 4.

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[13] The alternative measures are the "first-dollar" and "next-dollar" MTR. In the case of interest payments the "first-dollar" MTR estimates the tax savings from the first dollar of interest deducted by the firm while the "next-dollar" represents the reduction in tax were the firm to deduct an additional dollar of interest beyond the deductions taken in a given year. Under a progressive tax system, or in the presence of limited amounts of NOLs or tax credits to offset taxable income and tax liability, the three MTRs need not be the same.

[14] Cordes and Sheffrin (1981, 1983) and Dobbins et al. (1988) have provided estimates of corporate marginal tax rates derived from firm specific tax return data. Plesko (1998) used marginal tax rates at the industry level to examine leverage decisions surrounding the Tax Reform Act of 1986.

[15] A hybrid approach is suggested by Manzon and Shevlin (1995) who argue that for NOL carryforward firms the market value approach of Manzon (1994) provides a less biased and more accurate estimate of tax rates than the simulation approach.

[16] Graham (1996b) and Shevlin (1999) both point out the "true" MTR is unobserved.

[17] At the industry level, Plesko (1998) finds present value marginal tax rates to be highly correlated with current year tax rates, but that present value rates are better at explaining aggregate leverage changes.

Table 4
Tax return data used to calculate the current year marginal tax rate

| Data item | Tax form and line | Data item | Tax form and line |
|---|---|---|---|
| *Calculation of regular tax* | | *Alternative minimum tax (AMT)* | |
| Employer identification number | 1120 | Taxable income before net operating loss deduction | 4626, line 1 |
| Total deductions | 1120, line 27 | Total adjustments | 4626, line 2(n) |
| Net income | 1120, line 28 | Tax preference items | 4626, line 3(j) |
| Net operating loss deduction (NOLD) | 1120, line 29(a) | Pre-adjustment alternative minimum taxable income (AMTI) | 4626, line 4 |
| Interest paid | 1120, line 18 | Adjusted current earnings (ACE) | 4626, line 5(a) |
| Special deductions | 1120, line 29(b) | Excess of ACE to AMTI | 4626, line 5(b) |
| Income subject to tax | 1120, line 30 | 75% of ACE AMTI difference | 4626, line 5(c) |
| Controlled group code | 1120, Schedule J, line 1 | Excess of AMTI from prior year ACE adjustments | 4626, line 5(d) |
| Tax bracket 2a(i)—first $50,000 | 1120, Schedule J, line 2a(i) | Intermediate ACE calculation | 4626, line 5(e) |
| Tax bracket 2a(ii)—next $25,000 | 1120, Schedule J, line 2a(ii) | ACE adjustment | 4626, line 6 |
| Income tax | 1120, Schedule J, line 3 | Adjustment based on energy preferences. | 4626, line 7 |
| Foreign Tax Credit | 1120, Schedule J, line 4(a) | Alternative tax net operating loss deduction. | 4626, line 8 |
| Possessions Tax Credit | 1120, Schedule J, line 4(b) | AMTI | 4626, line 10 |
| Orphan Drug Credit | 1120, Schedule J, line 4(c) | AMT exemption amount | 4626, line 11(a) |
| Nonconventional Source Fuel Credit | 1120, Schedule J, line 4(d) | AMT exemption calculation | 4626, line 11(b) |
| General Business Credit | 1120, Schedule J, line 4(e) | AMT exemption amount | 4626, line 11(c) |
| Prior year minimum tax credit | 1120, Schedule J, line 4(f) | AMTI after exemption | 4626, line 12 |
| Total credits | 1120, Schedule J, line 5 | AMT | 4626, line 13 |
| Income tax after credits | 1120, Schedule J, line 6 | AMT Foreign Tax Credit | 4626, line 14 |
| Personal Holding Company Tax | 1120, Schedule J, line 7 | Tentative minimum tax | 4626, line 15 |
| Alternative minimum tax | 1120, Schedule J, line 9(a) | Income tax before credits minus Foreign Tax Credit | 4626, line 16 |
| Environmental Tax | 1120, Schedule J, line 9(b) | Alternative Minimum Tax | 4626, line 17 |
| Total tax settlement | 1120, Schedule J, line 10 | | |
| Shareholder of Controlled Foreign Corporation | 1120, Schedule K. line 6 | *Additional information for the General Business Credit* | |
| Total assets | 1120, Schedule L, line 15 | Tentative General Business Credit | 3800, line 7 |
| Liabilities and stockholders' equity | 1120, Schedule L, lines 16–26 | Credits before General Business Credit | 3800, Part II, line 9 (h) |

The CYMTR calculation consisted of a two-stage process. Based upon the information in the return, the tax liability of each firm was calculated and compared to the reported liability. In 21,545 cases the reported liability could not be exactly calculated based upon the tax return information, with an average error of approximately $48,000 (1.25%). These differences in calculated tax liability from that reported on the form could be caused by two factors. First, the necessary information to accurately calculate the tax may not have been supplied by the taxpayer. This was particularly true in cases of controlled groups, where the amount of 15 and 25% taxable income allocated across the unconsolidated entities is not well reported, making it difficult to determine the actual allocations used by the firm. These firms will generally be excluded from the final sample used in this paper as the entities comprising the financial and tax reporting units will be different. Second, in determining each firms' deductions and credits, the modeling assumes firms will minimize their tax liability, even though the return may show what appears to be non-minimizing behavior.[18]

CYMTR was calculated on a last-dollar basis by increasing each firm's total deductions by one-half of 1%, as all information to calculate such a rate, particularly carryforward and credit usage, is provided in the tax return. The ability to estimate the CYMTR on additional income may not be as precise as firms may not report loss carryforwards or credits in excess of those used in the calculation of their liability. So as to attribute changes in tax liability solely to the simulated change in income, rather than to modeling differences, changes in income and tax liability are measured as the difference from the two calculated values of the tax return, rather than a difference from reported values.

Working with tax return data yields important advantages over other measures by providing more detail and allowing for greater interaction among features of the tax code. For example, Graham (1996a, b), points out that financial statement information requires one to either exclude important aspects of the tax code (such as the Foreign Tax Credit) or to make strong assumptions about their operation (in the case of the AMT). Both of these features are potentially important in calculating MTRs as FTCs offset more than 20% of the total amount of taxes owed before credits in 1992 while the AMT increased corporate tax liabilities by $3.89 billion (3.78%).

Tax return data also eliminates the problem of incorrectly identifying firms' current year tax position. Within the sample used here, slightly more than 15% of the firms have taxable income of a different sign than their pretax book income, with 89% of those firms reporting positive pretax book income and negative taxable income.

After imposing the same consolidation and data requirements used in analyzing ATRs, 586 firms remain in the sample. Table 5 presents the summary statistics of the MTR calculated from tax returns, CYMTR, along with those of Graham and Manzon. While Graham has simulated MTRs before interest deductions have been taken (a first-dollar MTR) I use the rate after all interest has been deducted as it is conceptually similar to the method for calculating the CYMTR from the tax return.

[18] McGrath and McCann (2000) describe a similar problem in modelling Canadian corporations.

Table 5
Marginal tax rate proxies: Definitions and descriptive statistics

| Variable | Measure of marginal tax rate | Mean | Std. dev. |
|---|---|---|---|
| CYMTR | Marginal tax rate after credits, calculated from the firm's tax return after increasing net income by one-half of one percent of deductions | 0.233 | 0.128 |
| BINARY1 | Binary variable equal to the statutory rate (0.34) if there are no net operating loss carryforwards (prior year Compustat data item 52 equal to zero) | 0.212 | 0.165 |
| BINARY2 | Binary variable equal to the statutory rate (0.34) if there are no net operating loss carryforwards (prior year Compustat data item 52 equal to zero) and the firm reports positive pretax book income (Compustat data item 170) | 0.186 | 0.169 |
| TRICHOTOMOUS | Trichotomous variable equal to the statutory rate (0.34) for firms reporting positive pretax book income and no NOL carryforwards, 0.17 for firms reporting either negative pretax book income or an NOL carryforward, and 0 for firms with negative pretax book income and NOL carryforwards | 0.250 | 0.108 |
| STATUTORY | Equal to 0 if the firm has no pretax book income and a net operating loss carryforward, 0.15 if the firm has no pretax book income and no net operating loss carryforward, 0.25 if the firm has positive pretax book income and a net operating loss carryforward, and 0.34 if the firm has positive pretax book income and no net operating loss carryforward | 0.236 | 0.137 |
| UNIFORM | Same as above except rates are mapped into evenly spaced increments between 0 and the statutory rate: 0, 0.1133, 0.2266, 0.34 | 0.230 | 0.139 |
| Manzon (1994) | Equal to the statutory rate (0.34) for firms with positive income, discounted to reflect the expectation of the time to become taxable for others | 0.292 | 0.098 |
| Graham (1996b) | Simulated marginal tax rate after interest deductions have been taken | 0.193 | 0.160 |

Sample size: 586.

In calculating Manzon's measure I assume a discount rate of 0.14, with alternate rates yielding similar results.

In addition to the measures described above, five additional proxies are included in the analysis. Previous empirical studies have used dummy variables to capture tax differences between firms, with the variable taking the value of one if the firm reports NOL carryforwards. To capture the effects of dummy variables in a way comparable to the other proxies, BINARY1 is set equal to zero if the firm reports a NOL carryforward in the prior year, and is equal to the statutory rate of 0.34 otherwise. BINARY2 is defined the same as BINARY1 but also requires the firm to report positive pretax book income in order to be assigned the statutory rate. The extent of misclassification of current year tax status for BINARY1 (14%) is similar to the amount of misclassification in the signs of taxable and book income reported above, however the type of misclassification changes. In BINARY1, two-thirds of the misclassified firms do not report having NOL carryforwards but are not taxable. The additional condition imposed in BINARY2 reduces the number of firms misclassified to 9%, with roughly one-third of the misclassified firms incorrectly classified as not taxable.

The variable TRICHOTOMOUS is based upon Shevlin (1990) and Graham (1996b), and equals the statutory rate if the firm has positive income and no NOL carryforwards, zero if the firm has negative income, and one-half of the statutory rate if it reports both positive income and NOL carryforwards.

Two additional proxies are included, both of which are extensions of TRICHOTOMOUS in that they can take on one of four values. The first, STATUTORY, assigns the firm to one of the statutory tax rates based upon the combination of pretax book income (positive or non-positive) and the presence of NOL carryforwards. The second, UNIFORM, uses the same classification scheme as STATUTORY but assigns tax rates in evenly spaced increments between zero and the statutory rate. A histogram of CYMTR and each financial statement-based proxy is presented in Fig. 2.

Of the seven tax proxies reported in Table 5, in all but two cases (STATUTORY and UNIFORM) we reject the null hypothesis that the differences in the variables from CYMTR have a mean of zero. Shapiro-Wilk tests reject the hypotheses that differences between any of the tax proxies and CYMTR are normally distributed at any measurable level of significance.

Table 6 presents the results of estimating Eq. (4) for each of the financial statement-based MTRs. In contrast to the results reported in Table 2 for ATRs, the univariate $\beta$s are much higher, with all but two of the measures (TRICHOTOMOUS and Manzon) having coefficients greater than 0.500. Graham's measure and BINARY2 have the highest $\beta$s, 0.907 and 0.874 respectively.[19] These coefficients

[19] This paper uses Graham's "updated" tax rates rather than the originally published set. A comparison of the two series suggests they are not interchangeable, and the interpretation of empirical results will be sensitive to the series used. For 1992, the correlation between the two series (5,148 matched firms) is 0.790 and the estimate of ë from regressing the new series on the old is 0.727. For the firms in Table 6 with data from both the old and new series, the estimate of $\lambda$ is 0.742.

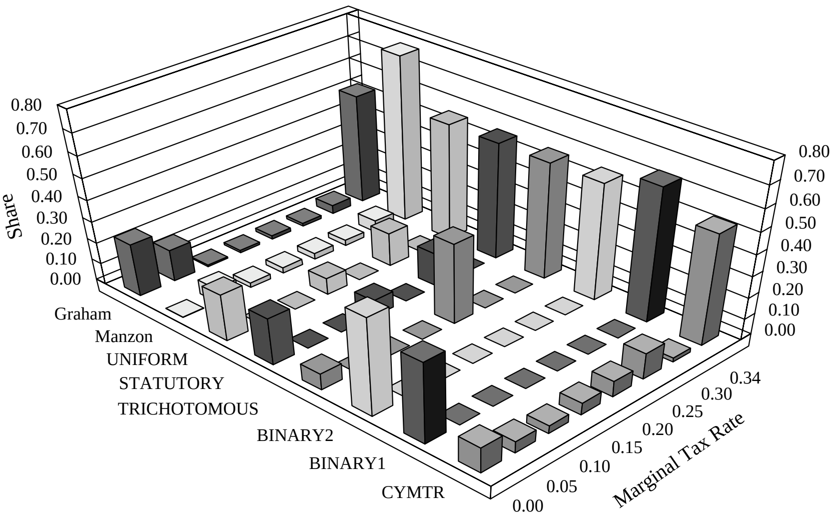


Fig. 2. Distribution of marginal tax rate estimates.

Table 6
Estimated reliability ratios for marginal tax rate measures

| Measure | $\rho$ | Univariate $\beta$ | Bivariate $\beta$ | Multivariate $\beta$ |
|---|---|---|---|---|
| BINARY1 | 0.562 | 0.774(0.037) | 0.711(0.043) | 0.712(0.047) |
| BINARY2 | 0.604 | 0.874(0.032) | 0.834(0.040) | 0.819(0.043) |
| TRICHOTOMOUS | 0.519 | 0.487(0.024) | 0.479(0.028) | 0.464(0.031) |
| STATUTORY | 0.500 | 0.760(0.031) | 0.731(0.034) | 0.718(0.036) |
| UNIFORM | 0.521 | 0.778(0.030) | 0.749(0.034) | 0.735(0.035) |
| Manzon (1994) | 0.422 | 0.295(0.031) | 0.255(0.033) | 0.256(0.035) |
| Graham (1996b) | 0.646 | 0.907(0.027) | 0.867(0.032) | 0.835(0.036) |

$\rho$ is the correlation coefficient between each financial statement measure and the tax return measure of the marginal tax rate. The $\beta$s were estimated from variants of the following equation of financial statement estimates of tax rates ($\tau_{\text{financial}}$) and tax return-based tax rates ($\tau_{\text{tax}}$):

$$\tau_{\text{financial}} = \beta_0 + \beta_1 \tau_{\text{tax}} + \sum_{i=2}^{N} \beta_i X_i.$$

The univariate $\beta$ is the estimated coefficient from a regression of the tax return-based measure on the financial statement measure. Bivariate $\beta$ regressions include the log of assets as an additional explanatory variable. In the multivariate regressions, the additional covariates are log of assets, capital intensity (net PPE/total assets), $Z$-score, and industry controls (nine one-digit SIC code dummy variables). Sample sizes are 586 for the univariate and bivariate regressions, 553 for the multivariate. Standard errors are in parentheses.

remain fairly stable as ln(Assets) and other covariates[20] are added, as shown in the next two columns. In column three both Graham and BINARY2 have estimated values of $\lambda$ in excess of 0.800.

Following the sensitivity tests for the ATR measures, Eq. (4) was reestimated for the subset of 134 non-consolidated firms (not reported in the tables). With the exception of Manzon's measure the univariate $\beta$s across all specifications increase relative to those presented in Table 6, with the estimate of $\lambda$ for BINARY2 rising to 0.985 and Graham to 0.918. After all the covariates are added, BINARY2 has the highest coefficient, at 0.859, with the coefficient on Graham's simulated tax rate falling to 0.793. For these firms, it appears that controlling for the current year marginal effects of corporate taxes can be done as effectively with easily constructed binary or other categorical variables as with more complicated approaches of estimating present value MTR.

That a binary variable can be as highly correlated with the current year tax rate as Graham's continuous variable is appears to be counterintuitive, but a closer examination of the data, and of Fig. 2, reveals that Graham's measure has less variation than one might expect based upon its methodology. Of the 586 observations, Graham places only 11% between 0.03 and 0.31, compared to 34% for CYMTR. The lack of mid-range values is not a result of the sample restrictions of this paper, as the original sample of 6,156 observations in Graham's data set has only 13% of firms within this range.[21]

The statistical relation of both Graham's MTR and BINARY2 to CYMTR suggests that BINARY2 may also be a better proxy for Graham's MTR than TRICHOTOMOUS or the other variables suggested in his paper (Graham, 1996b, p. 209). To test this, Eq. (4) was reestimated using both the consolidated and non-consolidated samples of domestic firms with Graham's measure substituted for CYMTR as the explanatory variable, paralleling the tests of Table 6. The estimated coefficients for BINARY2 across the three specifications averaged 0.87 for the consolidated sample and 0.93 for the unconsolidated sample, slightly larger than for BINARY1 (0.76 AND 0.83) but substantially greater than the 0.49 and 0.52 for TRICHOTOMOUS. Within this sample, BINARY2 serves as a better substitute for Graham's (1996b) simulated rates than the alternatives tested in his paper.

This distribution of estimated tax rates suggests MTR proxies, even those estimated to have high values of $\lambda$, should not be viewed as continuous variables. Researchers should be careful in interpreting coefficients on these variables, and recognize that coefficients on such variables may not represent the effects of infra-marginal changes in the tax rate of a firm, but rather more closely resemble the movement of a firm from a low (or zero) MTR to a high (or statutory maximum) marginal rate.

[20] The additional covariates beyond ln(Assets) are capital intensity (net PPE/total assets), Altman's $Z$-score (as implemented by Graham (1996a)), and industry controls for one-digit SIC classifications.

[21] Graham's measure will also be affected by the misclassification of firms' current tax status. Similar to the errors reported earlier for the binary variables, 15% of the firms in the sample are assigned a zero tax rate by Graham even though they report a positive tax liability on their tax return.

Table 7
Marginal tax rates by income and NOL position

| | NOL carryforward = 0 | NOL carryforward > 0 |
|---|---|---|
| Pretax book income ⩽ 0 | 0.170(0.013){0.077} | 0.083(0.008){0.220} |
| Pretax book income > 0 | 0.310(0.005){0.546} | 0.204(0.009){0.157} |

$n = 589$; adjusted $R^2 = 0.890$.
This table reports the coefficients from a regression of four dummy variables representing a firm's pretax book income (PTI) and NOL carryforward status on the firm's CYMTR:

$$\mathrm{CYMTR}_i = \beta_1 D_{1,i}^{\substack{\mathrm{PTI}\leqslant 0\\ \mathrm{NOLCF}=0}} + \beta_2 D_{2,i}^{\substack{\mathrm{PTI}\leqslant 0\\ \mathrm{NOLCF}>0}} + \beta_3 D_{3,i}^{\substack{\mathrm{PTI}>0\\ \mathrm{NOLCF}=0}} + \beta_4 D_{4,i}^{\substack{\mathrm{PTI}>0\\ \mathrm{NOLCF}>0}}.$$

The coefficient estimates represent the mean CYMTR of firms with those characteristics. Standard errors are in parentheses; all coefficients are significant at greater than 0.01. Values in braces represent the share of the sample's observations in that group.

The ability of discrete measures to capture variations in MTRs suggests the joint classification of firms by their profitability and the presence of an NOL carryforward, as suggested by Shevlin (1990), might be used to better classify firms with current year tax rates between zero and the statutory maximum.

Table 7 presents the results of the following regression:

$$\mathrm{CYMTR}_i = \beta_1 D_{1,i}^{\substack{\mathrm{PTI}\leqslant 0\\ \mathrm{NOLCF}=0}} + \beta_2 D_{2,i}^{\substack{\mathrm{PTI}\leqslant 0\\ \mathrm{NOLCF}>0}} + \beta_3 D_{3,i}^{\substack{\mathrm{PTI}\leqslant 0\\ \mathrm{NOLCF}=0}} + \beta_4 D_{4,i}^{\substack{\mathrm{PTI}\leqslant 0\\ \mathrm{NOLCF}>0}}, \tag{6}$$

where the $D_i$ represent the four combinations of pretax book income (positive or less than or equal to zero) and NOL carryforward (either positive or zero). Each of the four coefficients are statistically significant and distinct from each other, suggesting the mean CYMTR of firms in each group is different. As predicted by Shevlin, firms with the highest estimated CYMTR have positive pretax book income and no NOL carryforward (0.310) while firms with nonpositive pretax book income and an NOL carryforward have the lowest CYMTR (0.083). Together, these two scenarios account for nearly 77% of the sample firms. Of the remaining two groups, firms with positive pretax book income and NOL carryforwards have the second highest CYMTR (0.204), while firms with nonpositive income and no NOL carryforwards have an estimated CYMTR of 0.170 – identical to the midpoint rate assigned in TRICHOTOMOUS. These results suggest the inclusion of an additional dummy variable equal to one if the firm has positive pretax book income along with the traditional NOL dummy variable could cross-sectionally capture the intermediate states of taxation better than either a binary or trichotomous variable.[22] Further, this approach yields easily interpretable coefficients representing distinct states of firms' financial positions.

[22] In contrast to the 0.890 adjusted $R^2$ reported in Table 7, the adjusted $R^2$ for a univariate regression of the TRICHOTOMOUS variable on CYMTR is 0.334.

## 8. Summary and conclusions

While taxes are an important element in corporate decision making, determining a firm's tax liability is based upon a separate set of rules than income reported to shareholders, and its presentation is filtered through financial accounting standards. The results of this paper suggest that commonly used financial statement-based measures of corporate ATRs measure the statutory corporate tax burden with significant error. When used as explanatory variables, the coefficients on these variables will understate the effects of the tax system on firm behavior unless financial reporting values influence behavior rather than the tax reporting values. Further, the distribution of financial statement-based ATRs, and the characteristics used to explain the distribution of these tax rates, do not appear to carry over to understanding the distribution of statutory tax burdens.

MTR proxies derived from financial statements appear to provide relatively reliable estimates of the MTR facing firms in the current year, and the coefficients on these variables will only slightly understate the effects of taxation. Three measures of MTR, the current year MTR derived from the tax return, the present value MTR simulated from financial statements, and a simple binary variable based upon a combination of firms' income and NOL carryforward position, are found to be highly correlated with each other in the sample.

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