The Decreasing Trend in Cash Effective Tax Rates

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Abstract

This paper explores the previously documented decreasing trend in ETRs (Dyreng et al. 2017), which has been interpreted as increased tax avoidance by U.S. firms. We assume a linear tax function, where taxes paid are regressed on pre-tax income. The intercept captures taxes paid effects that are independent of current income and the slope coefficient is the marginal propensity to tax (MPT). In the presence of an intercept in the tax function, average ETRs are economically related to the MPT if pre-tax income is positive and exhibits a growth trend. Thus, although firms may have stable linear tax functions, indicating no systematic changes in their tax avoidance behavior, a decrease in average ETRs may be observed over time simply because of growth in pre-tax income. Specifically, average ETRs will decline (increase) and converge towards the MPT when there is a positive (negative) intercept and growth in income. We document a stable linear tax function for U.S. firms over the past 25 years, in which (i) the intercept is positive and (ii) pre-tax income is growing. The main implication of our findings is that the wholesale concerns regarding increased tax avoidance over time, measured by ETRs, are potentially overstated.

Keywords: Cash effective tax rate; Corporate tax function; Tax avoidance.
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I. Introduction

Although the U.S. statutory corporate tax rate has been constant since 1988, recent literature documents a decreasing trend in corporate cash effective tax rates (Cash ETRs) over the past twenty-five years (1988-2012) (Dyreng et al. 2017). This trend has been interpreted as an increase in firms' tax avoidance behavior over time.[1] However, despite anecdotes and public conjectures as to the source of this decline, changes in firm characteristics and earnings in foreign jurisdictions with declining statutory tax rates explain only a little of the overall decrease in ETRs. This study aims to extend the work of Dyreng et al. (2017) and explain this decreasing trend in Cash ETRs based on a simple economic model of a linear corporate tax function and its relation with income growth. While not common in the current literature, several papers have used a similar approach (see, Zimmerman 1983, Wilkie 1988, Shevlin and Porter 1992, and Dyreng and Lindsey 2009). We build on this prior work and provide a theoretical basis for this linear function based approach.

Specifically, assuming the following tax function $TXPD = a + bPI$ where the level of cash taxes, $TXPD$, is linearly related to the level of pre-tax income, PI, the intercept, a, captures taxes paid effects that are independent of current period's income whereas the product of the slope coefficient and income, bPI, captures tax effects that are directly associated with current income. The slope coefficient can be interpreted as the marginal propensity to tax (MPT) since it measures a firm's 'marginal' tax payment due to an additional dollar of current period pre-tax income.[2] Both

[1] We define tax avoidance as all activities undertaken by a firm to reduce their explicit tax burden for a given level of performance. The actions can range from benign activities such as investing in municipal bonds, to more aggressive actions such as participating in tax shelters. In contrast, prior literature (e.g., Dyreng et al. (2008), (2017), Hanlon and Heitzman (2010)) defines tax avoidance as taxes paid specifically relative to pre-tax income (i.e., all Cash ETR decreases). In this study we show how this difference in definition can impact inferences from the trend in Cash ETRs over the last 25 years.

[2] Note, in this setting "marginal" is used in the context of the derivative of the tax function. This is not to be confused with the similar but different concept of simulated marginal tax rates used in the tax literature (see for example Graham, (1996)). A key difference between Graham (1996) type marginal tax rates and ours is that Graham considers the time

the intercept a and the slope coefficient b will capture the impact of tax planning. The intercept will capture tax planning that is independent of the current level of pretax income (e.g., a claimed tax credit that is a fixed amount). The slope coefficient will capture tax planning that varies with current pretax income (e.g., income proportionally shifted to a lower tax jurisdiction).

Such linear tax functions have an inherent 'economic' relation between the average Cash ETR and the marginal propensity to tax (MPT) if the pre-tax income is positive and growing over time.[3] To reveal this key economic relation, we divide the above-mentioned tax function by pre-tax income leading to: $Cash\ ETR = TXPD/PI = a/PI + b$. Accordingly, the average Cash ETR is a function of the intercept a capturing 'current income independent' cash taxes paid effects, the marginal propensity to tax, b, and the pre-tax income, PI.[4] Assuming that the linear tax function is stable over time, our main prediction is given current period income independent taxes paid effects (i.e., in the presence of an intercept a in the tax function), average Cash ETRs are economically related to the MPT if the pre-tax income is positive and growing.[5]

In our main tests, we focus on the described Cash ETR function: $Cash\ ETR = TXPD/PI = a/PI + b$ and make two predictions that provide insights regarding the time series of Cash ETRs. We focus on whether Cash ETRs will exhibit an increasing or decreasing trend. First, for firms

value of money, whereas the derivative of the linear tax function does not; it simply measures the change in current taxes for a change in current pre-tax income.

[3] Similar economic relations exist also for negative incomes when they exhibit a growth trend. We will discuss these cases later on in more detail. In our main analysis, however, we focus on positive incomes and growth.

[4] Using the basic corporate tax function, $TXPD = a + bPI$ allows us to conceptually distinguish between average Cash ETRs, defined as: $Cash\ ETR = TXPD/PI$, and the marginal propensity to tax (MPT). The MPT is defined as the first derivative of the cash taxes paid with respect to pre-tax income: $MPT = dTXPD/dPI = b$ and captures the additional amount of tax for an additional dollar of pre-tax income. The average Cash ETR relates the entire amount of current cash taxes paid to the current pre-tax income. In contrast, the marginal propensity to tax describes a firm's 'marginal' tax payment due to an additional dollar of the pre-tax income (Scholes et al., 2016).

[5] We define a stable tax function in the context of linear tax functions of the type: $TXPD = a + bPI$ as one in which neither the intercept a nor the slope coefficient b exhibit systematic changes over time. Examples of 'pre-tax income-independent' components of $TXPD_{i,t}$ are intertemporal tax allocation effects, e.g., reversals/prepayments of cash taxes paid on prior/subsequent pre-tax earnings or effects not related to any pre-tax income such as income independent book-tax differences, i.e., tax-exempt earnings, non-deductible expenses, deductible items, credits, and NOLs.

where pre-tax income is positive and increasing, and where the 'income independent' cash taxes paid effect is positive, i.e., $a > 0$, average Cash ETRs will be 'economically' related to the MPT and will decline over time and converge from above towards the MPT ($MPT = b$). This relation is driven by the fact that for positive and growing income, the positive term a/PI in the Cash ETR function will decline and converge towards zero. Second, for firms where pre-tax income is positive and increasing over time and where the 'income independent' cash taxes paid effect is negative, i.e., $a < 0$, average Cash ETRs will be 'economically' related to the MPT and will increase and converge from below towards the MPT ($MPT = b$). This relation is driven by the fact that for positive and growing income, the negative term $-a/PI$ in the Cash ETR function will increase and converge towards zero. By economically related, we mean that the described decrease/increase in average Cash ETRs is not driven by firms' increased/decreased tax avoidance behavior – because the linear tax function describing the firm's tax behavior remains in both cases unchanged – but rather simply by the economic effect of growth which is unrelated to a firm's tax planning activities.

Consequently, although firms may have stable linear tax functions, indicating no systematic changes in their tax avoidance behavior over time, a decrease/increase in average Cash ETRs may be observed simply because of growth in the pre-tax income. Such a decrease/increase in average Cash ETRs, however, is not related to changes in a firm's tax planning behavior because the tax function remains unchanged and therefore should not be interpreted as tax avoidance. Thus, ignoring the growth effect of pre-tax income on the magnitudes of average Cash ETRs can lead to misleading inferences regarding the assessment of firms' tax avoidance behavior.

The existence of an intercept reflecting taxes paid effects independent of the current period's pre-tax income may arise from different sources that we formally discuss in section 2.2 and Appendix A in greater detail. In brief, first, Cash ETRs' validity suffer from a mismatch between the numerator and the denominator if the denominator captures the current period's earnings but the numerator contains taxes paid on accounting earnings from both the current and prior/subsequent periods (Hanlon and Heitzman, 2010). For example, cash taxes paid in the current period can relate to final payments for the prior period, refunds received for a prior period, payments or receipts related to IRS audits completed in the current year (tax arrears payments or tax refunds from prior periods), or because of reversing temporary book-tax differences reflecting both regular timing differences that reverse and intertemporal income shifting based on deferred tax expense strategies. Consequently, cash taxes paid in period t are likely to contain two components; first, cash taxes paid directly associated with the magnitude of the current period pre-tax income (bPI) and second, cash taxes paid on earnings from prior and future periods (a).

Second, other cash taxes paid effects that are 'current period's pre-tax income independent' are the result of pre-tax income independent book-tax differences (Wilkie, 1988). Pre-tax income independent book-tax differences are all 'items' that cause a firm's taxable income to be different from its pre-tax income, independently of current period's pre-tax income magnitude. Book-tax differences of this type include tax-exempt earnings, non-deductible expenses, the use of NOLs, tax credits, and minimum taxes. For example, NOL-effects will lead to a refund of prior taxes paid or to a deduction in future periods. Such prior tax effects can be viewed as tax refunds (negative cash taxes paid) associated with income in $t - s$, taking effect in period t. In both cases cash taxes paid effects will occur that are not related to the current pre-tax income. Further tax-exempt earnings, non-deductible expenses, and tax credits will also lead to cash taxes paid-effects which are independent of current pre-tax income. All these effects will be incorporated into the intercept of empirical linear tax functions since they are not directly related to current period's pre-tax income (see, section 2.2 and Appendix A).

We present empirical results that are consistent with our predictions. First, reproducing the sample from Dyreng et al., (2017), we document a stable linear tax function where the intercept a is positive and where pre-tax income is positive and growing. The existence of a stable tax function indicates no systematic changes in firms' tax avoidance behavior over time. Neither the intercept, capturing current period's income independent tax effects, nor the MPT change systematically over time (i.e., no change in income independent reductions in tax payments, and no change in the MPT, the proportion of current period income paid as taxes). Nevertheless, as predicted, we observe a decline in average Cash ETRs and a convergence of Cash ETRs toward the MPT over time. Since the tax function remains unchanged over time, the observed decrease in ETRs is caused by the increase in pre-tax income and is not related to firms' tax avoidance behavior. This finding is consistent with the observed decreasing trend in Cash ETR by Dyreng et al. (2017) and illustrates why firm characteristics, other than firm growth in pre-tax income and decreasing foreign tax rates, fail to fully explain the decreasing trend.

Next, based on the relations above, we further predict that for a subsample of firm-year observations with a stable tax function in which current period's income independent tax paid effects are negative, i.e., $a < 0$, and where pre-tax income is positive and growing over time, average Cash ETRs will increase and converge from below towards the MPT. Again, since the tax function remains unchanged over time, the increase in average Cash ETRs should not be interpreted as a change in firms' tax avoidance activities. The increase in ETRs is simply due to the negative intercept and the growth in income. Our results explain under which economic conditions an increasing Cash ETR trend will be observed.

We contribute to prior literature by showing that the 'economic' relation that is inherent in linear tax functions is a plausible explanation for the observed decreasing trend in the Cash ETRs of U.S. firms and helps us to understand why firm characteristics and declining foreign tax rates do not fully explain the decreasing trend. This relation provides an explanation for the decreasing trend in Cash ETRs that is not driven by increasing tax avoidance but is primarily related to growth in pre-tax income. Specifically, we show that although firms' linear tax functions remain unchanged over time, indicating no systematic changes in tax avoidance behavior, changes in average Cash ETRs may be observed simply because of pre-tax income's growth.

Due to the increasing disparty between the statutory tax rate and the continuously lowering effective tax rates, many have accused firms of not paying their fair share of taxes and have suggested that the U.S. tax system is broken. The main implication of our findings is that wholesale concerns regarding increasing tax avoidance over time are potentially overstated given the evidence of stable tax functions and their inherent economic relation between average Cash ETRs and the MPT in the presence of growth in pre-tax income.

The remainder of this study proceeds as follows. Section 2 provides a background on the theoretical concept of linear tax functions and their empirical estimation; it also develops the hypotheses. Section 3 describes the data, the full sample selection, and the subsample selections. Section 4 presents the results and section 5 concludes.

II. Theoretical background and hypotheses development

2.1 Tax functions in economics literature

Macro and microeconomics-based research oftentimes assumes linear-type tax functions in their models of the form:

$$T_t = a + bY_t \qquad (0)$$

where T_t denotes some measure of the tax burden in period t and Y_t some measure of taxable income in period t. The intercept a captures tax payments in time t that are independent of the current period's income if $a > 0$; and tax refunds/reductions in t that are independent of the magnitude of the current period's income if $a < 0$, respectively. The slope coefficient b denotes the marginal propensity to tax (MPT), which is defined as the incremental tax payment due to an additional dollar of taxable income (Helpman and Sadka, 1978; Cooter and Helpman, 1974; Romer, 1975). The economics literature often refers to the slope coefficient, b, as the 'marginal tax rate'. However, we note that this economics concept of marginal tax rates differs slightly in its definition from the Scholes-Wolfson framework used in accounting-based tax research (Scholes et al., 2016).[6]

Although the economics literature provides strong theoretical foundations as well as empirical evidence on the existence of linear tax functions, accounting research empirically testing the implications of linear corporate tax functions is rare. Evidence on corporate tax functions in accounting-based tax research has already been provided in e.g., Zimmerman (1983), Wilkie (1988), Shevlin and Porter (1991), Dyreng and Lindsey (2009), Hanlon and Slemrod (2009), Desai and Dharmapala (2006), and Atwood et al., (2012). The first three studies assume linear tax functions. The next three studies assume 'proportional' tax functions whereas the latter uses a linear multivariate tax function where the current tax expense is regressed on three explanatory variables to estimate the degree of book-tax conformity.[7] None of these studies, however, tests the predicted

[6] In the economics literature, linear tax function of the form: $T = a + bY$ are oftentimes assumed, where the slope coefficient b is defined as the 'marginal tax rate' (e.g., Helpman and Sadka (1978), p. 384). Note that in this context the terminology 'marginal' means the incremental current tax payment induced by an additional dollar of income in the current period and differs from the definition used in the Scholes-Wolfson framework of effective tax planning where the marginal tax rate is defined as "the effect on the present value of explicit taxes of earning another dollar of taxable income in the current period" (Scholes et al. (2016), pp. 193-195 and 511).

[7] Note that in 'proportional' tax functions of the form: $T = bY$, that is, where an intercept is missing, the average ETR (T/Y) equals the marginal propensity to tax $(dT/dY = b)$. Therefore, using 'proportional' tax functions instead of 'linear' tax functions implies $ETR = MPT$ and thus does not allow testing for differences between effective tax rates and the marginal propensity to tax. Further, all studies estimating the unobservable taxable income (TI) in accounting research by grossing up the current tax expense (TXC) by the statutory tax rate (str), i.e., $TI = TXC/str$, imply a 'proportional' tax function of the type: $TXC = strTI$. Dyreng and Lindsey (2009) include an intercept but essentially assume a proportional tax function as they do not focus on the role of the intercept. Atwood et al. (2012) estimate the

convergence implications between effective tax rates and the MPT empirically for U.S. corporations. Next, we provide a theoretical background on linear corporate tax functions and develop the hypotheses. A more rigorous theoretical explanation of corporate tax functions is presented in Appendix A.

2.2 Linear corporate tax functions

Based on Wilkie (1988), and starting with the assumption that there are no 'interperiod tax allocation effects', a firm's tax burden – which we measure as cash taxes paid, $TXPD$ – equals its taxable income, TI, multiplied by the statutory tax rate, str, minus tax credits, C (e.g., research and development credits and foreign tax credits):

$$TXPD_t^t = -C + strTI_t \tag{1}$$

where $TXPD_t^t$ denotes a firm's cash taxes paid in period t (subscript) that are economically related to period t (superscript). 'Interperiod tax allocation effects' arise either due to reversing temporary book-tax differences in period t that cause cash tax payments/refunds in period t actually associated with prior period pre-tax incomes or due to cash tax prepayments related to subsequent periods.

Taxable income is defined as pre-tax income, PI, plus or minus total book-tax differences, BTD, where book-tax differences are all items (including $NOLs$) that receive differential treatment under the tax law as compared to book accounting treatment (as reflected in PI) and thus cause taxable income and pre-tax income to diverge:

$$TI_t = PI_t - BTD_t \tag{2}$$

Total book-tax differences are likely to consist of two components, first, a pre-tax income

following linear multivariate tax function: $CTE_t = \theta_0 + \theta_1 PTBI_t + \theta_2 ForPTBI_t + \theta_3 DIV_t + e_t$, where CTE is current tax expense, $PTBI$ is pre-tax book income, $ForPTBI$ is foreign pre-tax book income, and DIV is total dividends. The residual e_t is aimed to measure the variation of book-tax conformity.

independent portion, θ_0, and second a portion that is directly associated with the magnitude of the pre-tax income, θ_1. We present examples of these various types of transactions in Appendix B. Initially, assuming that both components are constant over time leads to:

$$BTD_t = \theta_0 + \theta_1 PI_t \quad (3)$$

where the coefficient θ_1 can be interpreted as a relative book-tax differences coefficient (i.e., a proportional difference between tax and accounting income). Substituting equation (3) for BTD_t in equation (2), and this modification of equation (2) for TI_t in equation (1), and rearranging terms, yields:

$$TXPD_t^t = [-C - str\theta_0] + str(1 - \theta_1)PI_t \quad (4)$$

Taking into account that reported cash taxes paid in period t, $TXPD_t$, are likely to consist of cash taxes paid components that are directly associated with the current period, $TXPD_t^t$, but also with cash taxes paid effects related to prior and subsequent period's pre-tax incomes, i.e., $\sum TXPD_t^{s \neq t}$, reported cash taxes paid are given by:

$$TXPD_t = TXPD_t^t + \sum TXPD_t^{s \neq t} \quad (5)$$

Substituting equation (4) for $TXPD_t^t$ in equation (5) and rearranging term yields:

$$TXPD_t = \left[\sum TXPD^{s \neq t} - C - str\theta_0\right] + str(1 - \theta_1)PI_t \quad (6)$$

Equation (6) shows the corporate tax function on the conceptual level. Denoting $a = [\sum TXPD^{s \neq t} - C - str\theta_0]$ and $b = str(1 - \theta_1)$, gives:

$$TXPD_t = a + bPI_t \quad (7)$$

Equations (6) and (7) reveal the determinants of the tax function's intercept and the slope coefficient. Specifically, if a tax system allows for interperiod tax allocation effects, as is the case in the US because of the existence of timing differences between the two sets of books (i.e., temporary book-tax differences), the tax function will exhibit tax payments unrelated to the current period and thus an intercept. Moreover if a tax system allows tax credits (e.g., research and development and foreign tax credits), which are deductible from gross taxes, this will also be reflected in the intercept. The slope coefficient of the tax function is given by the product of the statutory tax rate and one minus pre-tax income dependent relative book-tax differences and can be interpreted as the MPT.

Since most tax systems allow for the described effects, assuming proportional tax functions of the form: $TXPD_t = bPI_t$ where an intercept a is missing, appears incomplete and can affect inferences drawn from ETRs about corporate tax planning.

Adding an error term to equation (7) leads to:

$$TXPD_t = a + bPI_t + \varepsilon_t \tag{8}$$

If indeed all interperiod tax allocation effects ($\sum TXPD^{s\neq t}$), tax credits (C), and pre-tax income independent book-tax differences (θ_0) are constant over time, the estimate of the intercept will measure the magnitude of this sum. If, however, the three determinants of the intercept exhibit variation over time, the estimated intercept will measure the mean magnitude of the three determinants whereas deviations from this mean will be captured in the residual (see Appendix A for a detailed derivation). The same applies to the slope coefficient. If pre-tax income dependent book-tax differences are constant over time (θ_1) the estimated slope coefficient will measure the MPT. If, however, θ_1 exhibits variation over time, the empirical estimate will measure the mean MPT and the deviations from this mean will be captured in the residual (see Appendix A for detailed derivation). In both cases, the two estimates of a and b can be used to make empirical predictions about the relations between average Cash ETRs and the MPT in the presence of growth in pre-tax income, and about whether Cash ETRs will exhibit a time trend.

However, the magnitude of the variation of the residuals (ε_t) can overlap and disturb the predicted associations. Specifically, (i) large variations in $\sum TXPD^{s \neq t}$, C, θ_0, and θ_1 in the tax function although assumed to be constant or (ii) a general existing low correlation between $TXPD_t$ and PI_t in the tax function may disturb our predictions and make it empirically not observable.

2.3 The relation between corporate tax functions and tax avoidance

2.3.1 Proportional tax functions, linear tax functions, and Cash ETRs

Generally, tax avoidance is broadly defined as the reduction of explicit taxes (Hanlon, Heitzman, 2010). Choosing the Cash ETR as a measure to capture tax avoidance has a number of embedded assumptions. Using this measure, tax avoidance will be captured when there are (i) decreases in cash taxes in period t for a given level of pre-tax income in t, i.e., $Cash\ ETR \downarrow = \frac{TXPD\downarrow}{\overline{PI}}$, but also (ii) increases in the level of the pre-tax income in period t for a given level of cash taxes in period t, $Cash\ ETR \downarrow = \frac{\overline{TXPD}}{PI\uparrow}$. This definition of tax avoidance implicitly assumes a proportional tax function (described in greater detail below), and registers firm behavior as tax avoidance when there is a deviation from the current proportional relation. This definition is equivalent to equation (7), but assuming an intercept equal to zero, $a = 0$, that is, where the tax function goes through the origin, cash taxes paid equal:

$$TXPD_t = bPI_t \tag{9}$$

In this case Cash ETRs are equal to the MPT (see Figures 1(A) and 1(B):

$$Cash\ ETR_t = \frac{TXPD_t}{PI_t} = b = MPT = \frac{dTXPD_t}{dPI_t} \tag{10}$$

In contrast, assuming the linear tax function (i.e., equation (7) with a non-zero intercept), Cash ETR is no longer equivalent to the slope coefficient. To illustrate the relation between the linear tax function of equation (7) and Cash ETR, we divide equation (7) by pre-tax income:

$$Cash\ ETR_t = \frac{TXPD_t}{PI_t} = \frac{a}{PI_t} + b \tag{11}$$

If a linear tax function is descriptive, even with no change in tax planning behavior (i.e., no changes in tax avoidance, Cash ETR will change with pre-tax income (i.e., as pre-tax income grows, the $\frac{a}{PI_t}$ term will shrink and Cash ETR will approach the MPT (see Figures 1(C) and 1(D)).

In sum, tax avoidance implies, and is measured, as deviations from a stable tax function. Using Cash ETR as a measure of tax avoidance assumes a proportional tax functions where taxes paid *should* only vary with pretax income. In contrast, a linear tax function allows for a pre-tax income independent component of taxes paid, in addition to variation in taxes with pre-tax income.

2.3.2 Proportional tax functions, linear tax functions, and tax avoidance

In this subsection we will explain how tax avoidance is captured by deviations from stable tax functions (i.e., intercept shifts or rotations in the slope) for both proportional and linear tax functions, and what those deviations are driven by.

First, given a *proportional* tax function of the form $TXPD = bPI$ both (i) decreases in cash taxes for a given level of pre-tax income, i.e., $Cash\ ETR \downarrow = \frac{TXPD\downarrow}{\overline{PI}} = b \downarrow$, and (ii) increases in the pre-tax income for a given level of cash taxes paid, $Cash\ ETR \downarrow = \frac{\overline{TXPD}}{PI\uparrow} = b \downarrow$, lead necessarily to decreases of the both the average Cash ETR and the MPT (see Figures 1(E) and 1(F)). Such decreases have been interpreted in the literature as changes in tax avoidance because they are necessarily related to a downward rotation of the proportional tax function, that is, to systematic changes of the firm's tax function (i.e., the tax function is not stable but rotating).

Second, given a *linear* tax function of the form $TXPD = a + bPI$ both (i) decreases in cash taxes for a given level of pre-tax income, i.e., $Cash\ ETR \downarrow = \frac{TXPD\downarrow}{\overline{PI}} = \frac{a(\downarrow?)}{\overline{PI}} + b(\downarrow?)$, and (ii) increases in the pre-tax income for a given level of cash taxes paid, i.e., $Cash\ ETR \downarrow = \frac{\overline{TXPD}}{PI\uparrow} = \frac{a(\downarrow?)}{PI\uparrow} + b(\downarrow?)$, will imply decreases of (i) a, or (ii) b, or (iii) a and b, for a decrease in Cash ETRs. Such decreases can be interpreted as tax avoidance because they are necessarily related to a downward (i) shift (decrease of a), or (ii) downward rotation (decrease of b), or (iii) both downward shift and a rotation (decrease of a and b) of the linear tax function. Such changes in the tax function indicate systematic changes in the firm's tax planning behavior (see Figures 1(G) and 1(H)).

These equations and plots illustrate that, (i) assuming a proportional tax function (as using Cash ETR as a measure of tax avoidance assumes), lower ETRs are always assumed to be caused by tax avoidance since they can only be observed after a downward rotation of the tax function. However, always interpreting decreases in Cash ETRs as tax avoidance is incomplete and misleading if there are stable linear tax functions, i.e., when a ($\neq 0$) and b are constant over time. Because, in contrast to proportional tax functions (where there is no way for Cash ETRs to decrease without a rotation of the tax function being interpreted as tax avoidance), assuming a linear tax function decreases in Cash ETRs may be observed that are not related to systematic changes in a firm's tax planning behavior and thus should not be interpreted as tax avoidance. Such decreases are simply due to the growth of pre-tax income. Again, assuming a linear tax function, deviations from that function (i.e., intercept shifts or slope rotations) capture tax avoidance.

In summary, regardless of the functional form assumed for the tax function, shifts and/or rotations in the function will be the empirical measure of tax avoidance. If there is a time trend in tax avoidance (i.e., tax avoidance is increasing over time), this will be observed empirically through a pattern of increasing error terms over time. This implies that if a linear tax function is descriptive, tax planning behavior is stable if the function is stable (i.e., the error term is stochastic). In our analysis below, we examine if this is the case in the U.S. over the last 25 years.

2.4 Hypotheses development

Returning to our primary equation of interest, the calculation of Cash ETRs assuming a linear tax function, equation (11) reveals 4 main predictions about the relation between Cash ETRs and the MPT, as well as about the trend inherent in Cash ETRs depending on the sign of the intercept (positive or negative), the sign of pre-tax income (positive or negative) and its evolution over time (increasing/decreasing). Figure 2 illustrates the four cases while assuming a MPT of 0.30.[8]

Tax function type I: $PI_t > 0$, $a > 0$

The first type of corporate tax function describes a linear relation between the level of cash taxes paid and the level of pre-tax income with both a positive intercept and a positive and increasing current pre-tax income. The positive intercept, $a > 0$, reflects the component of cash taxes paid that is independent of current period's pre-tax income, e.g., reversing temporary book-tax differences in period t that cause cash tax payments in period t related to prior periods pre-tax incomes or current tax prepayments on future income such as unearned revenue in period $t + 1$. The first quadrant of Figure 2 shows based on equation (11), i.e., $Cash\ ETR_t = \frac{TXPD_t}{PI_t} = \frac{a}{PI_t} + b$, the corresponding relation between the average Cash ETR and the MPT for tax function type I. Given a positive intercept a, average Cash ETRs will decrease and converge from above towards the marginal propensity to tax b with a positive and increasing magnitude of pre-tax income

[8] As an example, we arbitrarily assume a marginal propensity to tax (MPT) of 0.30 to outline the associations between average Cash ETRs and the MPT in Figure 2. The outlined associations remain basically the same if a different MPT is assumed, e.g., $MPT = 0.2$. The only thing that changes if a different level of MPT is assumed is the level to which the average Cash ETRs converges if pre-tax income increases. Assuming a MPT of 0.30 roughly implies a mean relative book-tax differences level of 0.15, i.e., $MPT \approx 0.30 \approx str(1 - 0.15)$ where $str = 0.35$. Further, the outlined associations in Figure 2 assume that the tax function has the same marginal propensity to tax for both loss firm-year observations and for firm-year observations with a positive pre-tax income. However, it is reasonable to assume that the marginal propensity to tax for loss-tax functions will be flatter than for tax functions with a positive pre-tax income, i.e., will have a lower marginal propensity to tax.

because the component $\frac{a}{PI_t}$ in (11) will decrease and converge towards zero if pre-tax income increases. We therefore hypothesize:

> *H1: For firm-year observations with a positive intercept, $a > 0$, in the tax function, average Cash ETRs will decrease and converge from above towards the marginal propensity to tax (MPT) if pre-tax income is positive and increasing.*

Tax function type II: $PI_t > 0$, $a < 0$:

The second type of corporate tax functions describes a linear relation between the level cash taxes paid and the level of pre-tax income with a negative intercept and a positive and increasing current pre-tax income. The negative intercept, $a < 0$, again reflects the component of cash taxes paid that is independent of current period's pre-tax income. A negative intercept, however, indicates e.g., reversing temporary book-tax differences in period t that cause cash tax refunds taking effect in period t that are related to prior period's pre-tax incomes. The second quadrant outlined in Figure 2 shows, based on equation (11), the corresponding relation between the average Cash ETR and the MPT for tax function type II. Given a negative intercept a, average Cash ETRs will increase and converge from below towards the MPT with a positive and increasing magnitude of the pre-tax income because the component $\frac{a}{PI_t}$ in (11) will decrease and converge towards zero if pre-tax income increases. We therefore hypothesize:

> *H2: For firm-year observations with a negative intercept, $a < 0$, in the tax function, average Cash ETRs will increase and converge from below towards the marginal propensity to tax (MPT) if pre-tax income is positive and increasing.*

Tax function types III and IV: $PI_t < 0$, $a > 0$ and $PI_t < 0$, $a < 0$

On the conceptual level the prediction for linear tax functions for loss observations as shown in Figure 2 are straightforward. Provided that the negative pre-tax income has a decreasing trend, for a positive intercept, $a > 0$, average Cash ETRs will increase and converge from below towards the MPT (see Figure 2, function type III) and for a negative intercept, $a < 0$, average Cash ETRs will decrease and converge from above towards the MPT (see Figure 2, function type IV).

Empirically, however, several doubts exist that could cause the predicted associations for loss firms not to be observed. From an economic perspective, losses do not occur as systematically as profit do. Consequently, we might not observe a stable linear tax function for loss-year observations. Further, losses receive a different tax treatment than profits do and tax planning strategies could differ significantly depending on whether a firm earns a profit or incurs a loss. Thus, the correlations between cash taxes paid and pre-tax income are likely to be much lower for loss years than for profitable years leading to lower r-squares in loss-tax functions. A low r-square in the tax function is consistent with a high variation in the tax functions' residual. We therefore do not make explicit predictions for the associations between Cash ETRs and the MPT for tax function types III and IV. However, we will provide some empirical evidence on those two types.

III. Data and sample selection

3.1 Full sample

We begin our sample selection following Dyreng et al., (2017) (DHMT herein). We differ from DHMT in that we do not exclude firm-year observations with negative pre-tax income and negative cash taxes paid. Specifically, we include all non-financial and non-utility firm-year observations listed in Compustat with available data. We examine the time period 1988-2012 to ensure a period with a constant statutory tax rate and we only include U.S. firms in our analyses. There are 116,125 firm-year observations that fulfill these requirements. We require non-missing values for pre-tax income and cash taxes paid, which decreases our sample size to 90,976 firm-year observations. Cash ETRs greater than one are set to one; Cash ETRs less than minus one are set to minus one to ensure ETRs to range within $-1 \leq Cash\ ETR \leq 1$. Finally, in order to estimate firm-specific regressions, we require each firm to have at least five years of data for pre-tax income and cash taxes paid. These data criteria result in a sample of 81,421 firm-year observations including 6,452 unique firms for the variables pre-tax income, cash taxes paid, and Cash ETRs. Except for the Cash ETR, all other variables are winsorized at 1 and 99%. Table 1, Panel A, presents the descriptive statistics for the full sample. The mean Cash ETR is 0.171, lower than prior research that typically excludes loss firms and reset negative ETRs to zero. The mean logarithm of total assets is 5.493 and the mean firm is profitable (mean ROA = 0.03). The average firms pays $30.37 million in income taxes and reports pre-tax income of $97.32 million.

3.2 Dyreng, Hanlon, Maydew, Thornock, (2017) sample

Next, we drop all firm-year observations with a negative pre-tax income (loss of 22,467 firm-year observations) and negative cash taxes (loss of 2,344 firm-year observations). These restrictions ensure a Cash ETR interval of $0 \leq Cash\ ETR \leq 1$, consistent with the sample criteria chosen in DHMT, and lead to a final subsample of 56,610 firm-year observations, including 6,182 unique firms for the variables pre-tax income, cash taxes paid, and Cash ETRs. Table 1, Panel B reports the descriptive statistics on this subsample. The descriptive statistics are consistent with those reported by DHMT. Their sample includes 54,028 observation, compared to the 56,610 observations for which we calculate a Cash ETR. Cash ETRs are similar (i.e., 0.297 versus 0.291 in DHMT) and observation are similar in other attributes (e.g., size, measured as the natural logarithm of total assets is 5.692 versus 5.938 in DHMT).

3.3 Identifying firm-year observations for the tax function types I to IV

In order to provide empirical evidence on our hypotheses, we first need to identify the observations that belong to each quadrant of Figure 2. We do so by first estimating firm-specific regressions of pre-tax income on a time variable:

$$PI_t = c + gTIME_t + v_t \tag{12}$$

where $TIME_t$ takes on the values 1, 2, 3, … 25 for the time period 1988-2012. We estimate equation (12) to identify whether the pre-tax income of a specific firm has an increasing ($g > 0$), a decreasing ($g < 0$), or no time-trend ($g \approx 0$) in the time-series of its pre-tax income over time. We then estimate regressions of the firm-specific tax function from equation (8). Once empirical firm-specific estimates of the parameters$g$, a, and b, are obtained, we assign all 81,421 firm-year observation to the tax function types I to IV by applying the requirements described below.

3.3.1 Subsample A: tax function type I

In order to test H1, that growing firms (g > 0 estimated from equation 12) with income independent tax payments will have Cash ETRs that are decreasing over time towards the MPT, we first drop all firm-year observations with a negative pre-tax income (loss of 22,467 firm-year observations). Further, we only include firm-year observations with a positive intercept, $a > 0$ (loss of 7,669 firm-year observations) that is significant at least at a 10% level, i.e., t-statistic > 1.319, (loss of 14,730 firm-year observations) from the firm-specific regression (8). These requirements lead to a final sample size of 36,555 firm-year observations including 3,974 unique firms for the variables pre-tax income, cash taxes paid, and Cash ETRs. Table 2, Panel A reports the descriptive statistics on this subsample.

3.3.2 Subsample B: tax function type II

In order to test H2, that growing firms (g > 0) with income independent tax reductions will have Cash ETRs that are increasing towards the MPT, we again exclude all firm-year observations with a negative pre-tax income. In contrast to the subsample of firm-year observations chosen for case I, we now only keep observations with a significant negative intercept, $a < 0$ that is significant in (8) at least at a 10% level, i.e., t-statistic < -1.319. These requirements lead to a final sample size of 1,539 firm-year observations including 151 unique firms for the variables pre-tax income, cash taxes paid, and Cash ETRs. Table 3 reports the descriptive statistic of this subsample.

3.3.3 Subsample C: tax function type III

In this subsample, we aim to identify a tax function for loss firm-year observations with a positive intercept indicating a certain level of firms' cash taxes payments although no profits are earned. We therefore exclude all observations with positive pre-tax income (loss of 58,947 firm-year observations) and only include firm-year observations with a positive intercept. Since losses are less persistent than profits and losses occur less systematically, we do not expect the variables cash taxes paid and pre-tax income for the tax functions III and IV to be as highly correlated as the tax functions in I and II. That is, we do not expect stable linear tax functions for the types III and IV. We require the intercept estimates to be positive, $a > 0$ (loss of 1,385 firm-year observations) that is significant at least at a 10% level, i.e., t-statistic > 1.319, (loss of 11,673 firm-year observations). The chosen criteria lead to a final sample size of 9,416 size firm-year observations including 2,026 unique firms for the variables pre-tax income, cash taxes paid, and Cash ETRs. Table 4, Panel A reports the descriptive statistics of this subsample.

3.3.4 Subsample D: tax function type IV

In our last subsample, we aim to identify a tax function for loss firm-year observations with a negative intercept indicating a certain level of firms' cash tax refunds. We impose the same criteria as for subsample C. We exclude all firm-year observations with a positive pre-tax income (loss of 58,947 firm-year observations) and a negative intercept (loss of 20,981 firm-year observations) that is significant at least at a 10% level, i.e., t-statistic < -1.319, (loss of 1,387 firm-year observations). As might be expected, the chosen criteria lead to a small final sample size of 106 firm-year observations including 19 unique firms for the variables pre-tax income, cash taxes paid, and Cash ETRs. Table 4, Panel B reports the descriptive statistics of this subsample.

IV. Empirical analysis and results

4.1 Results based on aggregate regressions of tax functions

4.1.1 Empirical tax function for aggregated observations

Consistent with Dyreng et al. (2017), we first conduct our tests at the aggregate level, that is, we investigate the evolution of mean Cash ETRs, $MEAN(Cash\ ETR)_t$, over time. The mean value is calculated for each year between 1988 and 2012 based on firm-specific Cash ETRs by aggregating them over, and dividing them by, the number of firms included in the respective subsample. Accordingly, we calculate the mean of cash taxes paid, $MEAN(TXPD)_t$, and the mean of the pre-tax income, ($MEAN(PI)_t$), in the same way to test our hypotheses at the aggregate level. The corresponding aggregate tax function is given by:

$$MEAN(TXPD)_t = a + bMEAN(PI)_t + MEAN(\varepsilon)_t \quad (13)$$

4.1.2 Results on H1: growing pre-tax income and positive income independent tax payments

H1 predicts that if linear tax functions are empirically descriptive, at the firm or aggregate level, and if the tax function's intercept a is positive, average Cash ETRs will decline and converge from above towards the MPT, b, for a positive and growing pre-tax income. To provide empirical evidence on this hypothesis, we first calculate annual mean values of cash taxes paid and pre-tax income for the subsample A (tax function type I) observations. Figure 3(A) illustrates that the calculated mean pre-tax income has an increasing trend over time.

Next, we calculate annual mean values of Cash ETR that are presented in Figure 3(B). Visual inspection of Cash ETR's mean values reveals a decreasing trend over time. We now estimate the linear regression from equation (13) to provide more formal evidence on our first hypothesis: Table 5 Panel A reports, and Figure 3(C) illustrates, the regression results. Both the intercept $a = 11.28$

(t-Stat. 8.84) and the slope coefficient $b = 0.194$ (t-Stat. 19.86) are significant at the 1% significance level. The intercept estimate of 11.28 is 28.2% of the mean value of cash taxes paid in our sample (11.28/40.00=0.1623). Thus, on average, 28% of the current cash taxes paid reported in period t do not vary with the current pre-tax income reported in period t. The estimated MPT, b, is 0.194. Thus, on average, the marginal dollar of current pre-tax income is taxed at 19.4%.

H1 predicts that if the pre-tax income is positive and increasing over time and if the intercept is positive, $a > 0$, than the average Cash ETR will decrease and converge from above towards the MPT, which we estimate as 0.194. Figure 3(D) illustrates that our empirical estimates of the theoretical relation illustrated in quadrant I of Figure 1, are consistent with our first hypothesis. The mean Cash ETR reported in Figure 3(D) is decreasing and converging from above towards the estimated MPT. The average yearly decrease amounts to -1.6%. The variation around the decreasing Cash ETR trend is due to the volatility of the mean residual from equation (13) that slightly disturbs the predicted economic relation of a decreasing Cash ETR towards the MPT. Figure 3(E) illustrates the time series properties of the error term, which does not exhibit a statistically significant time trend. This lack of a time trend in the error term is consistent with a stable aggregated tax function. Specifically, both the intercept a and the slope coefficient b measuring the difference between book and taxable income being stable over time.

4.1.3 Results on H1 based on a high growth firm sample

To provide additional evidence on H1, we make a cross-sectional prediction that the decrease in Cash ETRs will be steeper in high growth firms. To examine this cross-sectional variation in H1, we condition subsample A on high growth firms. In doing so, we use the estimated growth trend parameter g from equation (12). The estimates of g have a mean of 7.79 and a maximum of 345.43. To ensure a high growth trend in the pre-tax income of firms included in subsample A, we only include firms in the high growth subsample with g-values larger than 75. This decreases the sample size of 36,555 firm-year observations to 912 firm-year observations.

Figure 4(A) illustrates the evolution of the means of pre-tax income and cash taxes paid within the high growth firms' subsample. The mean pre-tax income has grown, on average, with a yearly rate of 8%. In contrast, the mean pre-tax income reported in Figure 3(A) has grown, on average, at a yearly rate of 5%. Similar to the Cash ETRs in Figure 3(B), the Cash ETRs illustrated in Figure 4(B) also exhibit a decreasing trend over time. Table 5 Panel B and Figure 4(C) report the regression results of equation (13) for this subsample of high growth firms. Both the intercept (t-Stat.: 9.46) and the slope coefficient (t-Stat.: 26.73) are significantly positive at the 1% level.

The slope coefficient, representing the MPT, is 0.198 and is of a similar magnitude as the slope coefficient for the subsample A (0.194). The estimated intercept of $a = 88.38$, however, differs significantly in its magnitude from the intercept estimated in Panel A ($a = 11.28$). This fact explains the steeper yearly decrease of the mean Cash ETR that amounts to -2.1%, illustrated in Figure 4(D), as compared to the Cash ETR decrease in Figure 3(D) (yearly decrease of -1.6%). For relatively low magnitudes of pre-tax income, Cash ETRs for firm-year observations with a high intercept (88.38) will be higher than for firm-year observations with a low intercept (11.28). Since the estimated marginal propensities to tax in Panel A and B are quite similar (0.194 and 0.198) the Cash ETR illustrated in Figures 3(D) and 4(D) converge over time almost towards the same level of approximately 20%. However, since the intercept estimated in Panel B is larger than the one estimated in Panel A, the decrease reported in Figure 4(D) is steeper. Figure 4(D) also illustrates the same picture as Figure 3(C) being consistent with H1. If the intercept of the tax function is positive and if the pre-tax income is positive and growing over time, average Cash ETRs will decrease and converge from above toward the MPT. This result is consistent with H1 indicating that the higher the growth trend inherent in a firm's pre-tax income the steeper the decrease in its average Cash ETR. As was the case in Figure 3(E), Figure 4(E) illustrates a stationary error term (i.e., the time trend is statistically not significant) over time consistent with a stable tax function where the intercept a and the slope coefficient b remain unchanged over time.

4.1.4 Results on H1 based on the DHMT (2017) sample

Without imposing any further restrictions on the sample presented in Table 1, Panel B (i.e., the DHMT subsample), again we compute annual means of pre-tax income and cash taxes paid, and present these results in Figure 5. The means of pre-tax income and cash taxes paid are both positive and increase over time. A comparison of the descriptive statistics reported in Table 1, Panel B with the statistics reported in DHMT (at p. 446) yield a similar distribution of the Cash ETRs. Figure 5(A) plots the annual mean values of cash taxes paid and pre-tax income. We note that pre-tax income is positive on average and has an increasing trend over the sample period. Figure 5(B) illustrates the same decreasing trend in mean Cash ETRs reported by DHMT.

Estimation of equation (13) on the DHMT sample leads to the results presented in Figure 5(C) and Table 5 Panel C. Both the intercept (t-Stat.: 6.93) and the slope coefficient (t-Stat.: 33.96) are statistically significant. The intercept is positive and is 6.65; the slope coefficient is estimated as 0.23. The relative amount of cash taxes paid that relates to pre-tax incomes from other periods than t equals 15.88% (0.1588=6.66/41.88). An r-squared of 0.9763, as well as the scatter diagram in Figure 5(C), provide strong evidence on the existence of a stable linear tax function.

Figure 5(D) shows that plotting the average Cash ETRs against the estimated MPT of 0.23 for the DHMT (2017) sample leads to results consistent with H1. Since the DHMT (2017) sample's tax function has a positive intercept and a positive and growing mean pre-tax income, the average Cash ETR decreases and converges from above towards the MPT of 0.23. As illustrated in Figure

5(E), the error term does not exhibit a statistically significant time trend. These properties inherent in linear tax functions explain the observed decreasing trend in the DHMT (2017) study and provide an explanation why firm characteristics and decreasing foreign tax rate fail to explain it.

4.1.5 Results on H2: growing pre-tax income and negative income independent tax payments

To test H2, we again use firm-specific estimates of the intercept a and restrict the sample to firm-year observations with a significant negative intercept, $a < 0$ (required significance level of 10%, i.e., t-Stat. < -1.319). This reduces our sample to 1,539 firm-year observation for the variables pre-tax income, cash taxes paid, and Cash ETR. Based on this subsample, we next compute annual mean values of cash taxes paid and pre-tax income; Figure 6 illustrates the evolution of both variables over time. Mean pre-tax income and mean cash taxes paid are positive and both increase significantly during the sample period. Plotting the mean of cash taxes paid against the mean of pre-tax income leads to the scatter diagram presented in Figure 6(C). The corresponding regression is reported in Table 5 Panel D. The estimated intercept is negative; -4.65 (t-Stat.: -4.94). This implies that, on average, 8% of the current cash taxes paid in period t are not related to the current pre-tax income reported in period t; 8% (0.079=-4.65/58.56). Thus, firms in this subsample receive, on average, 8% of their total current cash taxes payments back in period t in form of cash taxes refunds because of intertemporal tax planning in the form of reversing temporary book-tax differences from prior periods.

The estimated slope coefficient representing the MPT is 0.28 (t-Stat.: 73.59) and is higher than the MPTs for the subsamples above. Thus, firms with a high MPT appear to avoid taxes through tax planning strategies which, on average, result in refunds from prior periods. In contrast, firms facing a low MPT seem to care less about this type of intertemporal tax planning strategies which leads to cash tax refunds; instead they paid taxes in period t which were due in prior periods.

H2 predicts that if the pre-tax income is positive and increasing over time and if the intercept is negative, $a < 0$, than the average Cash ETR will increase and converge from below towards the MPT. Figure 6(D) illustrates the results for H2, which are consistent with our second prediction. The mean Cash ETR reported in Figure 6(D) is increasing and converging from below towards the MPT of 0.28 during the sample period providing consistent results with H2. As illustrated in Figure 6(E), the error term does not exhibit a significant time trend consistent with a stable tax function.

4.1.6 Results on loss firm-year observations

To test the predicted association of tax function type III, i.e., $PI < 0$ and $a > 0$, we calculate the mean values of pre-tax income and cash taxes paid for the subsample C. Figure 7(A) illustrates the evolution of both variables over time. There is a clear decreasing trend in the mean of the negative pre-tax income over the sample period. The mean of cash taxes paid is positive and slightly increasing over time. Thus, although firms in this subsample have decreasing losses over time, they still pay a certain amount of taxes ($a > 0$), which is due to reversing temporary book-tax differences from periods, and this amount of taxes paid is slightly increasing over time. Estimating the tax function (13) on this subsample leads to the results reported in Table 5 Panel E and illustrated in Figure 7(C). The r-squared of 0.2635 in this regression is clearly lower than in the regressions of the tax function types I and II (which were all above 90%). This result is consistent with our prediction of a low association between cash taxes paid and pre-tax income for loss observations. The intercept is positive and is estimated significantly at the 5% level (t-Stat.: 2.10), and amounts to 3.25. This means that 41.5% of the mean cash taxes paid (0.4148=3.25/7.835) in this subsample is due to cash tax payments related to reversing temporary book-tax differences and thus related to pre-tax incomes from periods other than the current period. Surprisingly, the MPT is negative, indicating that the higher the magnitude of losses the higher a firms' cash tax payments.

While we do not investigate this relation in detail, possible explanations for this include firms with larger losses in absolute terms could be larger firms that have more taxable entities (some of which are profitable for tax purposes but not observable at the consolidated level), firms with large pre-tax loss report substantial write-downs for book purposes that are not tax deductible, and firms included in this subsample making bigger losses have exhausted loss carryback provisions and are now creating higher loss carry forwards.

The only change in our prediction when the MPT is negative is that average Cash ETRs will be negative. But still, with an decreasing negative pre-tax income and a positive intercept, $a > 0$, negative average Cash ETRs will increase and converge from below towards the negative MPT. Figure 7(D) illustrates the results, which are consistent with this prediction. Again, as illustrated in Figure 7(E), the error term does not exhibit a significant time trend.

To examine our fourth prediction we calculate the annual means of cash taxes paid and pre-tax income and document no significant correlation between the two variables, as well as magnitudes for the intercept and the slope coefficient in the tax function type IV which are close to zero. This could be due to the very small sample size of 109 firm-year observations. Under such conditions no associations between Cash ETRs and the MPT seem to exist.

Overall, our results for profitable firm-year observations are strongly consistent with predictions. Our results for loss firm-year observations are less so. A plausible explanation for this result is the convexity in the U.S. (and many other) tax systems created around zero income due to limitations in loss carrybacks.

4.2 Results based on pooled regressions of tax functions

Next, we perform a number of similar analyses on a pooled sample of firm-year observations during the same sample period. These analyses differ from above in that we do not condense observations down to annual means. Doing this allows for the inclusion of a number of firm-specific variables, including lags and leads of pre-tax income, that further helps support our explanation of the time trend in Cash ETRs.

4.2.1 Empirical tax function for pooled observations

Summarizing all discussed determinants of corporate tax functions in section 2.2 as well as in Appendix A for a panel data set leads to:

$$TXPD_{i,t} = a_i + str\left(1 - \theta_{1i,t}\right)PI_{i,t} + TXPD_{i,t}^{t+1} + \sum_{t=1}^{T} TXPD_{i,t}^{t-T} + \varepsilon_{i,t} \tag{14}$$

where $b = str(1 - \theta_{1i,t})$. Since prior literature has shown that the variation in relative book-tax differences, or the degree of book-tax conformity, is a function of various factors commonly shown to affect average effective tax rates (Wilkie 1988, Dyreng et al. 2017), we model the MPT as time varying and as a function of the following determinants:[9]

$$\begin{aligned}(1 - \theta_{1i,t}) = (1 - \bar{\theta}_1) &+ \beta_1 TREND_{i,t} + \beta_2 MNE_{i,t} + \beta_3 XRD_{i,t} + \beta_4 PPE_{i,t} \\ &+ \beta_5 INTAN_{i,t} + \beta_6 LEV_{i,t} + \beta_7 CAPX_{i,t} + \beta_8 XAD_{i,t} + \beta_9 SPI_{i,t} \\ &+ \beta_{10} SPI_{i,t-1} + \beta_{11} NOL_{i,t-1} + \beta_{12} dNOL_{i,t-1}\end{aligned} \tag{15}$$

where *TREND* is a time variable taking on the value 1 to 25 for the years 1988-2012, *MNE* is an indicator variable for multinationals and is equal to one if the current-year pre-tax foreign income (*PIFO*) is greater than zero or if the absolute vale of the foreign tax expense (*TXFO*) is greater than zero, *XRD* is research and development expenses in a given year scaled by the level of sales; if missing, it is set to zero, *PPE* is the ratio of net property, plant, and equipment to total assets, *INTAN* is intangible assets to total assets, *LEV* is leverage calculated as the current year amount of total debt (*DLTT+DLC*) scaled by total assets, *CAPX* is the total amount spent on capital assets

[9] See Appendix A for a detailed description of θ.

scaled by net property, plant, and equipment, *SPI* is computed as the level of special items divided by total assets; if missing, it is set to zero, *NOL* is an indicator variable equal to one if Compustat reports a tax-loss carryforward (*TLCF*) at the end of the previous year, and zero otherwise. Advertising expenditures (*XAD*) is the ratio of advertising expense to the level of sales; if missing, it is set to zero, and *dNOL* is the change in net operating losses, scaled by lagged total assets.

Substituting equation (15) for $(1-\theta_{1i,t})$ in equation (14) and multiplying out gives:

$$\begin{aligned} TXPD_{i,t} = a_i &+ str(1-\bar{\theta}_1)PI_{i,t} + \beta_1 TREND_{i,t} * strPI_{i,t} + \beta_2 MNE_{i,t} * strPI_{i,t} \\ &+ \beta_3 XRD_{i,t} * strPI_{i,t} + \beta_4 PPE_{i,t} * strPI_{i,t} + \beta_5 INTAN_{i,t} \\ &* strPI_{i,t} + \beta_6 LEV_{i,t} * strPI_{i,t} + \beta_7 CAPX_{i,t} * strPI_{i,t} + \beta_8 XAD_{i,t} \\ &* strPI_{i,t} + \beta_9 SPI_{i,t} * strPI_{i,t} + \beta_{10} SPI_{i,t-1} * strPI_{i,t} \\ &+ \beta_{11} NOL_{i,t-1} * strPI_{i,t} + \beta_{12} dNOL_{i,t-1} * strPI_{i,t} \\ &+ \sum_{t=1}^{T} TXPD_{i,t}^{t-T} + \varepsilon_{i,t} \end{aligned} \tag{16}$$

Assuming that cash tax payments from prior periods affecting $TXPD_{i,t}$ are proportional to prior pre-tax incomes and limiting the number of time lags in $\sum_{t=1}^{T} TXPD_{i,t}^{t-T}$ to $T = 3$ as well as the number of leads to $t+1$ yields:

$$\begin{aligned} TXPD_{i,t} = a_i &+ bPI_{i,t} + \alpha_1 TREND_{i,t} * PI_{i,t} + \alpha_2 MNE_{i,t} * PI_{i,t} + \alpha_3 XRD_{i,t} \\ &* PI_{i,t} + \alpha_4 PPE_{i,t} * PI_{i,t} + \alpha_5 INTAN_{i,t} * PI_{i,t} + \alpha_6 LEV_{i,t} * PI_{i,t} \\ &+ \alpha_7 CAPX_{i,t} * PI_{i,t} + \alpha_8 XAD_{i,t} * PI_{i,t} + \alpha_9 SPI_{i,t} * PI_{i,t} \\ &+ \alpha_{10} SPI_{i,t-1} * PI_{i,t} + \alpha_{11} NOL_{i,t-1} * PI_{i,t} + \alpha_{12} dNOL_{i,t-1} * PI_{i,t} \\ &+ b_1 PI_{i,t+1} + b_2 PI_{i,t-1} + b_3 PI_{i,t-2} + b_4 PI_{i,t-3} + \varepsilon_{i,t} \end{aligned} \tag{17}$$

where the α_i's correspond to the product of the respective β_i and the statutory tax rate (str).

4.2.2 Main results on pooled regressions

Table 6 Panel A presents the results for the pooled DHMT firm-year sample. Column 1 presents the baseline result of a pooled regression where taxes paid are estimated on pre-tax income and an intercept including firm-fixed effects. We note that the "constant" terms reported in the tables is a mean of the firm fixed effects, therefore it represents the average intercept for the pooled sample of firms. Column 2 adds the firm level independent variables and a time trend. Column 3 adds 3 lags of pre-tax income. Finally, column 4 adds a lead of pre-tax income (and drops the third lag of pre-tax income to maintain the same data requirements in terms of contiguous observation). In column 1, both the intercept (estimate: 9.209) and the slope coefficient (estimate: 0.214) are estimated at statistically significant levels and are generally consistent with the estimates from the regression of annual means presented in Table 4. Adding the firm level variables and the time trend produces similar (intercept: 11.57, slope coefficient: 0.236) statistically significant estimates. The time trend variable is also significantly positive, although the magnitude is small (coefficient: 0.0016). To demonstrate the importance of changes in pre-tax income to the model we add three lags in column 3. The slope coefficient, the MPT, remains relatively similar (coefficient: 0.204). The three lags of pre-tax income are all positive and statistically significant, and the intercept falls (estimate: 7.963). Taken together, this evidence is consistent with a portion of current taxes paid being associated with past income. Also of note, the time trend variable is no longer statistically significant and the estimated coefficient is near zero (coefficient: -0.0004). Replacing the third lag of pre-tax income with a lead of pre-tax income produces similar results (MPT: 0.197, intercept: 6.985, insignificant time trend).

In Table 6 Panels B, C, and D, we repeat this analysis on the Type I tax functions (i.e., $PI > 0$ and $a > 0$), Type II tax functions (i.e., $PI > 0$ and $a < 0$), and the full pooled sample. The comparison of the results in Panel B (type I tax function) and in Panel C (type II tax function) reveals interesting evidence on two different types of tax planning firms. Considering the full model specifications for the tax function type I and II (i.e., Columns 4 in Panel B and Panel C) illustrate that firms with tax function type I pay a very low tax burden as measured by the MPT on the current income. These types of firms seem to focus on tax planning strategies that generate high levels of pre-tax income dependent book-tax differences (i.e., a large difference between the statutory rate of 0.35 and the MPT of 0.109 as measured by θ_1), thus reducing the current tax payments. At the same time these types of firms seem to also engage in intertemporal income shifting using temporary book-tax differences, which leads to high reversals of cash tax payments from prior periods as reflected in the positive and significant intercept of 13.14.

In contrast, firms with tax function type II have a significantly higher MPT of 0.329 (Panel C, Column 4) indicating that this type of firm does not engage in tax planning strategies that create high pre-tax income independent book-tax differences and thus pay a higher amount of cash taxes on the current income. However, the overall current tax payments are reduced by implementation of intertemporal tax planning strategies that lead to cash tax payment reductions in the current period as reflected in a negative intercept of -8.320. Thus, performing regressions of linear tax functions provides more precise insights on firms' tax planning strategies than simply considering their average Cash ETRs, which correspond to the sum of tax payments related to the current income and reversing intertemporal cash tax payments or cash tax refunds, respectively. For completeness Panel D presents the results from the full pooled sample. Inferences from this sample are similar to those obtained when using the DHMT sample in Panel A and discussed above.

4.2.3 Results on multinational versus domestic firms

The conventional wisdom is that multinational firms have more tax planning opportunities than purely domestic firms and therefore it is expected that multinationals should have lower effective tax rates than domestic firms. Dyreng et al. (2017), however, document the striking result that multinational firms, on average, have higher average Cash ETRs during their 25-year sample period than domestic firms.

We provide additional evidence related to this somewhat surprising result by performing pooled regressions of the linear tax function models on separate subsamples of multinational and purely domestic firms. Our conjecture is that owing to the U.S. system of worldwide taxation with deferral and the high U.S. statutory rate, multinational firms have greater opportunities for intertemporal income shifting. Consequently, we expect the intercept of the linear tax function, capturing the mean effect of cash tax reversals from prior periods in period t to be larger than the intercept of purely domestic firms. Given the evidence from DHMT, a high intercept for multinational firms is likely to cause the overall average Cash ETR to be higher than for domestic firms. Accordingly, reversing tax payments from prior periods of multinational firms is a plausible explanation for the documented higher Cash ETRs in DHMT. Table 7 presents our results of pooled regressions estimated separately for multinationals (Panel A) and purely domestic firms (Panel B).

Column 1 in Panel A (B) presents the result of estimating the linear tax function model for multinationals (purely domestic firms). The results indicate that multinationals pay a lower amount on taxes on current income compared to domestic firms (MPT of 0.212 vs. 0.248) and is consistent with multinationals having greater tax planning opportunities to reduce the current tax burden. Also consistent with multinational firms having more opportunities to shift income across time, the intercept for multinationals is significantly greater (16.23 vs. 2.033), representing a high amount of cash tax payment reversals in period t that economically belong to prior periods. Thus DHMT's puzzling result of higher Cash ETRs for multinational firms appears to be due to the sum of cash tax payments (i.e., taxes paid on the current income plus cash tax payment reversals) in the current period being higher. Further, our results illustrate that this does not mean that multinationals have fewer tax planning opportunities, as illustrated by the lower MPT. Finally, the results indicate that using average Cash ETRs might lead to incomplete inferences as average Cash ETRs do not distinguish between intertemporal tax effects and current tax payments.

Next, we extend the baseline regressions for both multinationals and domestics by including all previously noted control variables. Our aim is to test whether the initial results hold while controlling for the main determinants commonly documented to affect ETRs. Columns 4 presents the results of our full models. Including all control variables strengthen our initial results. The MPT for multinationals amounts only to 0.166 (Panel A, Column 4) whereas the MPT for purely domestic firms is now 0.324. Thus, multinationals appear to reduce their current tax payment as compared to domestics. The difference in the MPT of 15.8% reveals that multinationals pay only half of the amount of taxes on the current income as compared to domestics. The estimated intercept for multinationals in our full model is now 10.32. In contrast, and consistent with our conjecture, the estimated intercept for domestic firms is now not significantly different from zero.

Taken together, multinationals have higher average Cash ETRs because the sum of the current tax burden (i.e., the MPT) and cash tax reversals from prior periods (i.e., the intercept) is higher than the same sum for purely domestic firms. Separating the two effects and analyzing them on their own highlights a different picture, multinational firms pay only half of the amount on taxes on an additional dollar of the current income but the interperiod income shifting reverses, leading to higher total cash tax payments.

V. Conclusion

Prior research documents a decreasing trend in the mean values of Cash ETRs over the last 25 years (i.e., during the time period 1988-2012). Firm characteristics and declining foreign tax rates fail to explain this trend. We therefore aim to extend this literature and explain the decreasing trend based on the economic relation between average Cash ETRs and the MPT inherent in linear tax functions. In particular, $TXPD = a + bPI$-type tax functions allow us to conceptually distinguish between average Cash ETRs, defined as: $Cash\,ETR = TXPD/PI$, and the MPT, defined as: $MPT = dTXPD/dPI = b$. The intercept a captures the magnitude of all cash taxes paid in period t which are *independent* of current pre-tax income's magnitude. Because the Cash ETR and the MPT are 'economically' related by the following relation: $Cash\ ETR = TXPD/PI = a/PI + b$, for firm-year observations where $a > 0$ and where PI is positive and contains a growth trend over time, average Cash ETRs will decline and converge from above towards the MPT, b. We illustrate that for the sample used in Dyreng et al. (2017), the intercept a is positive and the pre-tax income contains a positive growth trend over time. This fact explains the reported decreasing Cash ETR trend and shows why firm characteristics and decreasing foreign tax rates fail to explain the declining trend in Cash ETRs. Further, we predict that for high growth firms with a tax function where $a > 0$ and where the pre-tax income is growing, the decline in average Cash ETRs will be steeper than for average growth firms and find consistent results with this prediction.

We also predict and find results consistent with, for firm-year observations with a positive pre-tax income but with a negative intercept, $a < 0$, average Cash ETRs increasing over time and converging from below towards the estimated MPT. Finally, we conduct tests where the pre-tax income is negative. As predicted, for firm-year observations where $PI < 0$ and $a > 0$, average Cash ETRs increase with the decreasing magnitude of losses and converges from below towards the MPT. Possibly due to a very small sample size for tax function type IV (109 firm-year obs.), we do not find any associations between average Cash ETRs and the MPT for this subsample.

Given that the majority of U.S. public firms have positive and growing pre-tax income, and exhibit that a portion of their current period tax payments are independent of their current reported pre-tax income, our results provide a plausible explanation for the decreasing time trend in Cash ETRs since 1988, extending the work of Dyreng et al. (2017). The 'economic' relation we illustrate that is inherent in the linear tax function is a plausible explanation for the observed decreasing trend in the cash effective tax rates of U.S. firms. This finding helps better understand why firm characteristics and declining foreign tax rates cannot fully explain the decreasing trend and provides an explanation for the decreasing trend in Cash ETRs that is not driven by increasing tax avoidance activity by firms but is primarily related to the growth in pre-tax income. These results also help illustrate why current period taxes do not vary solely based on pre-tax income, as ETR based measures of tax avoidance implicitly assume. One implication of this finding is that wholesale concerns regarding increasing tax planning over time, reflected in lower Cash ETRs, is potentially overstated given this economic relation with the growth in pre-tax income.

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Appendix A – The anatomy of linear corporate tax functions

This Appendix provides a detailed theoretical background of firm-specific linear corporate tax functions of the form: $TXPD_t = a + bPI_t$, presented in section II.[10] In particular, we show which determinants cause an intercept in the tax function and what are the determinants of the marginal propensity to tax (MPT).

1. A tax function without intertemporal cash taxes paid effects

1.1 Conceptual level: Intercept a and slope coefficient b are constant over time

Based on Wilkie (1988), and assuming that there are no intertemporal cash taxes paid effects, we begin with the fundamental definition that a firm's tax burden – which we measure as cash taxes paid, $TXPD$ – equals its taxable income, TI, multiplied by the statutory tax rate, str, minus tax credits, C (e.g., research and development credits and foreign tax credits):

$$TXPD_t^t = -C + strTI_t \tag{1a}$$

where $TXPD_t^t$ denotes a firm's cash taxes paid in period t (subscript) that are economically related to period t (superscript).[11]

Taxable income is defined as pre-tax income, PI, plus or minus total book-tax differences, BTD, where book-tax differences are all items (including NOLs) that receive differential treatment under the tax law as compared to book accounting treatment (as reflected in PI) and thus cause taxable income and pre-tax income to diverge:

$$TI_t = PI_t - BTD_t \tag{2a}$$

Total book-tax differences are likely to consist of two components, first, a pre-tax income independent portion, θ_0, and second a portion that is directly associated with the magnitude of the pre-tax income, θ_1; assuming that both components are constant over time leads to[12]:

$$BTD_t = \theta_0 + \theta_1 PI_t \tag{3a}$$

where the coefficient θ_1 can be interpreted as a relative book-tax differences coefficient. Substituting equation (3a) for BTD_t in equation (2a) yields:

$$TI_t = PI_t - (\theta_0 + \theta_1 PI_t) \tag{4a}$$

Additional substitution of equation (4a) for TI_t in equation (1a) yields:

$$TXPD_t^t = -C + str[PI_t - (\theta_0 + \theta_1 PI_t)] \tag{5a}$$

Now, multiplying out and rearranging terms leads to:

$$TXPD_t^t = [-C - str\theta_0] + str(1 - \theta_1)PI_t \tag{6a}$$

[10] Developing the theoretical foundation of the corporate tax function on a firm-specific level allows us to omit the firm-specific subscript i in the equations of this appendix and simplifies the notation.

[11] We introduce the superscript to distinguish between intertemporal cash taxes paid effects and to explicitly make clear that cash taxes paid as reported on firms financial statements likely not only include cash taxes paid related to period t but also the sum of cash taxes paid effects which are related to either prior or subsequent periods, $\sum TXPD_t^{s \neq t}$ (Hanlon and Heitzman, 2010).

[12] See Appendix B for examples.

Cash taxes paid in the tax function (6a) consist of two components. First, *cash taxes paid effects that are unrelated to current period's pre-tax income* as reflected by the first bracket term consisting of the sum of tax credits and pre-tax income independent book-tax differences multiplied by the statutory tax rate, i.e., $[-C - str\theta_0]$. Second, *cash taxes paid effects that are directly related to current period's pre-tax income* as measured by the second term), i.e., $str(1-\theta_1)PI_t$. *The coefficient relating current cash taxes paid effects to the current pre-tax income is the marginal propensity to tax*, MPT, given by: $MPT = str(1-\theta_1)$.

Equation (6a) can be rewritten as:

$$TXPD_t^t = a + bPI_t \quad (7a)$$

where the intercept is given by: $a = [-C - str\theta_0]$ and where MPT being the slope coefficient is given by: $b = str(1-\theta_1)$.

The tax functions in equation (6a) and (7a) show the determinants of the intercept and of the slope coefficient in linear corporate tax functions. Tax credits, C, and pre-tax income independent book-tax differences, θ_0, affect the intercept a of the tax function; specifically, tax credits and positive pre-tax income independent book-tax differences ($\theta_0 > 0$, i.e., $PI_t > TI_t$) reduce the value of the intercept whereas negative pre-tax income independent book-tax differences ($\theta_0 < 0$, i.e., $PI_t < TI_t$) increase the value of the intercept.[13] Further, income dependent book-tax differences, θ_1, decrease the slope coefficient of the tax function.

1.2 Empirical level: Intercept a and slope coefficient b are time-invariant

Adding an error term to equation (7a) gives the empirical tax function:

$$TXPD_t^t = a + bPI_t + \varepsilon_t \quad (8a)$$

If the tax function is correctly specified (e.g., there are no intertemporal cash taxes paid effects) and stable (i.e., the coefficients a and b are constant over time), the error term ε_t in equation (8a) will be stochastic and will not contain any economic information.

1.3 Conceptual level: Intercept a and slope coefficient b are time-varying

If, in contrast to subsection 1.2 above, neither the intercept nor the slope coefficient in the corporate tax function (8a) are constant but are time-varying, that is:

$$TXPD_t^t = a_t + b_tPI_t \quad (9a)$$

estimating regression (8a) and suppressing the time-variation of the intercept and the slope coefficient will lead to the estimated intercept and slope coefficient capturing only the mean effects of a_t and b_t. Further, the residuals from such a regression will contain economic information related to the variation in both the intercept and the slope coefficient.

To show these effects more clearly, we assume that both of the two components of the intercept and the slope coefficient in equation (6a) are (i) time-varying:

$$TXPD_t^t = [-C_t - str\theta_{0t}] + str(1-\theta_{1t})PI_t \quad (10a)$$

[13] Again, real world examples of these types of transactions are included in the body of the paper.

corresponding to $a_t = [-C_t - str\theta_{0t}]$ and $b_t = str(1-\theta_{1t})$ in equation (9a), and (ii) can be decomposed into their respective means and the deviations from their means over time:[14]

$$C_t = \bar{C} + C_t^* \tag{11a}$$

$$\theta_{0t} = \bar{\theta}_0 + \theta_{0t}^* \tag{12a}$$

$$\theta_{1t} = \bar{\theta}_1 + \theta_{1t}^* \tag{13a}$$

Substituting the assumptions (11a), (12a), and (13a) into equation (10a), and rearranging terms gives tax function's (10a) equivalent if tax credits and both pre-tax income independent and pre-tax income depended book-tax differences exhibit variation over time:

$$TXPD_t^t = [-\bar{C} - str\bar{\theta}_0] + str(1-\bar{\theta}_1)PI_t + [-C_t^* - str\theta_{0t}^* - str\theta_{1t}^* PI_t] \tag{14a}$$

1.4 Empirical level: Intercept a and slope coefficient b are time-varying

Estimating a linear tax function of the type:

$$TXPD_t^t = a + bPI_t + v_t \tag{15a}$$

in the presence of time varying tax credits and book-tax differences as documented in equation (14a), the estimated intercept will only capture the mean effect:

$$a = \bar{a} = (-\bar{C} - str\bar{\theta}_0) \tag{16a}$$

and the estimated slope coefficient on the current pre-tax income will only capture the mean marginal propensity to tax:

$$b = \bar{b} = str(1-\bar{\theta}_1) \tag{17a}$$

The empirical residual will then be given by:

$$v_t = \varepsilon_t - C_t^* - str\theta_{0t}^* - str\theta_{1t}^* PI_t \tag{18a}$$

Equation (18a) shows that suppressing the time-varying effects in the tax function's intercept and slope coefficient and assuming both to be constant over time will lead to a residual which consists of a stochastic error term, ε_t, variation of tax credits, C_t^*, and variation caused by both book-tax differences that are unrelated to current period's pre-tax income, $str\theta_{0t}^*$, and that are related to current period's pre-tax income, $str\theta_{1t}^* PI_t$.

2. Tax function with intertemporal cash taxes paid effects

2.1 Modelling of intertemporal cash taxes paid effects

As stated in Hanlon and Heitzman (2010), reported cash taxes paid in period t, $TXPD_t$, are likely to consist of cash taxes paid components that are directly associated with the current period, $TXPD_t^t$, but also with cash taxes paid effects related to prior and subsequent period's pre-tax incomes. Denoting cash taxes paid effects related to other than the current period, i.e., $s \neq t$,

as: $\sum TXPD_t^{s \neq t}$, reported cash taxes paid are given by:

[14] In our notation, we denote a variable's X_t mean value as $\bar{X}$ and the time-varying deviations from its mean as X_t^*, i.e., $X_t = \bar{X} + X_t^*$.

$$TXPD_t = TXPD_t^t + \sum TXPD_t^{s \neq t} \tag{19a}$$

Constraining cash taxes paid effects related to subsequent periods to $t + 1$ gives:

$$\sum TXPD_t^{s \neq t} = TXPD_t^{t+1} + \sum_{t=1}^{T} TXPD_t^{t-T} \tag{20a}$$

Equation (20a) can be rewritten as:

$$\sum TXPD_t^{s \neq t} = TXPD_t^{t+1} + TXPD_t^{t-1} + TXPD_t^{t-2} + \cdots + TXPD_t^{t-T} \tag{21a}$$

Assuming that subsequent and past cash taxes paid effects mainly depend on the respective subsequent and past pre-tax incomes, however, that some portion of these effects is pre-tax income independent, i.e., γ_t, gives:

$$\sum TXPD_t^{s \neq t} = \gamma_t + b_0 PI_{t+1} + b_2 PI_{t-1} + b_3 PI_{t-2} + \cdots + b_{T+1} PI_{t-T} \tag{22a}$$

where the coefficients, b_0, b_2, b_3, …, b_{T+1}, indicate associations between future and past pre-tax incomes and the current cash tax payments. Let

$$\delta_t = b_0 PI_{t+1} + b_2 PI_{t-1} + b_3 PI_{t-2} + \cdots + b_{T+1} PI_{t-T} \tag{23a}$$

and assuming that γ_t and δ_t can be decomposed into their means and deviations from these means:

$$\gamma_t = \bar{\gamma} + \gamma_t^* \tag{24a}$$

$$\delta_t = \bar{\delta} + \delta_t^* \tag{25a}$$

equation (22a) can be rewritten as:

$$\sum TXPD_t^{s \neq t} = (\bar{\gamma} + \gamma_t^*) + (\bar{\delta} + \delta_t^*) \tag{26a}$$

Equivalently, (26a) can be re-expressed as:

$$\sum TXPD_t^{s \neq t} = \sum \overline{TXPD}^{s \neq t} + \sum TXPD_t^{*s \neq t} \tag{27a}$$

where:

$$\sum \overline{TXPD}^{s \neq t} = (\bar{\gamma} + \bar{\delta}) \tag{28a}$$

and:

$$\sum TXPD_t^{*s \neq t} = (\gamma_t^* + \delta_t^*) \tag{29a}$$

2.2 *Conceptual level: Failure to control for intertemporal cash taxes paid effects*

Equations (19a) to (22a) show that in the presence of intertemporal cash taxes paid effects, the tax function becomes dynamic, where in addition to the current period's pre-tax income, future and past pre-tax incomes also affect cash taxes paid. Ignoring this fact will have the following consequences.

Substitution of equation (14a) for $TXPD_t^t$ and equation (27a) for $\sum TXPD_t^{s\neq t}$ in equation (19a), and rearranging terms after this substitution gives:

$$TXPD_t = \left[\sum \overline{TXPD}^{s\neq t} - \bar{C} - str\bar{\theta}_0\right] + str(1-\bar{\theta}_1)PI_t + \left[\sum TXPD_t^{*s\neq t} - C_t^* - str\theta_{0t}^* - \theta_{1t}^* strPI_t\right] \quad (30a)$$

Equation (30a) shows that in addition to tax credits and pre-tax income independent book-tax differences, cash taxes paid effects related to other than the current period will affect the magnitude of the intercept. On average, cash taxes payments related to subsequent and prior period, i.e., $\sum \overline{TXPD}^{s\neq t} > 0$ will increase the intercept, whereas cash tax refunds from prior periods, i.e., $\sum \overline{TXPD}^{s\neq t} < 0$, will decrease the intercept.

2.3 Empirical level: Failure to control for intertemporal cash taxes paid effects

Equation's (30a) empirical equivalent is given by:

$$TXPD_t = a + bPI_t + \omega_t \quad (31a)$$

where the intercept captures the mean effect of:

$$a = \bar{a} = \left[\sum \overline{TXPD}^{s\neq t} - \bar{C} - str\bar{\theta}_0\right] \quad (32a)$$

and the slope coefficient on the current pre-tax income captures the mean marginal propensity to tax:

$$b = \bar{b} = str(1-\bar{\theta}_1) \quad (33a)$$

and where the residual is given by:

$$\omega_t = \left[\varepsilon_t + \sum TXPD_t^{*s\neq t} - C_t^* - str\theta_{0t}^* - str\theta_{1t}^* PI_t\right] \quad (34a)$$

2.4 Conceptual level: Controlling for intertemporal cash taxes paid effects

Substitution of equation (24a) for γ_t in equation (22a) gives:

$$\sum TXPD_t^{s\neq t} = (\bar{\gamma} + \gamma_t^*) + b_0 PI_{t+1} + b_2 PI_{t-1} + b_3 PI_{t-2} + \cdots + b_{T+1} PI_{t-T} \quad (35a)$$

Further, substituting equation (35a) for $\sum TXPD_t^{s\neq t}$ and equation (14a), the tax function without intertemporal effects, for $TXPD_t^t$ in equation (19a), the identity for current cash taxes paid equaling the sum on cash taxes paid in the current period related to all past and subsequent periods, and then rearranging terms yields:

$$TXPD_t = [\bar{\gamma} - \bar{C} + -str\bar{\theta}_0)] + str\ (1-\bar{\theta}_1)PI_t + [b_0 PI_{t+1} + b_2 PI_{t-1} + b_3 PI_{t-2} + \cdots + b_{T+1} PI_{t-T}] + [\gamma_t^* - C_t^* - str\theta_{0t}^* - str\theta_{1t}^* PI_t] \quad (36a)$$

Equation (36a) shows three determinants affecting the intercept of the tax function. First, $\bar{\gamma}$, i.e., the mean effect of cash taxes paid effects related to other than the current period ($s \neq t$) that are independent of the respective subsequent/past pre-tax income. Second, the mean effect of tax credits and third, the mean effect of pre-tax income independent book-tax differences multiplied by the statutory tax rate. Thus, cash taxes paid effects related to other than the current period will still affect the intercept's magnitude even after controlling for the impact of the subsequent and prior pre-tax incomes, however, the impact will be smaller, i.e., only $\bar{\gamma}$ affects the intercept and not $\sum \overline{TXPD}^{s \neq t} = (\bar{\gamma} + \bar{\delta})$. The coefficient on the current pre-tax income captures the mean marginal propensity to tax. The coefficients b_0, b_2, b_3, …, b_{T+1} relate cash taxes paid in period t to their respective subsequent/past pre-tax incomes. The last bracket term contains the deviations of our main variables from their means.

2.5 Empirical level: Controlling for intertemporal cash taxes paid effects

The empirical equivalent of equation (36a) is given by:

$$TXPD_t = a + bPI_t + b_0 PI_{t+1} + b_2 PI_{t-1} + b_3 PI_{t-2} + \cdots + b_{T+1} PI_{t-T} + \kappa_t \qquad (37a)$$

where the intercept captures the mean effect of:

$$a = \bar{a} = (\bar{\gamma} - \bar{C} - str\bar{\theta}_0) \qquad (38a)$$

the slope coefficient on the current pre-tax income captures the mean marginal propensity to tax:

$$b = \bar{b} = str(1 - \bar{\theta}_1) \qquad (39a)$$

and the residual is given by:

$$\kappa_t = \varepsilon_t + \gamma_t^* - C_t^* - str\theta_{0t}^* - str\theta_{1t}^* PI_t \qquad (40a)$$

Appendix B Examples of Interperiod Effects on Tax Payments

In this Appendix we present several examples of transactions that will result in income dependent book-tax difference (i.e., differences captured by θ_1), and income independent book-tax differences (i.e., differences captured by θ_0).[15]

Income dependent book-tax differences (i.e., θ_1),

Assuming that a corporation owns 2% of the stock of XYZ Corporation. During the period t, the corporation receives $10,000 of dividends from XYZ Corporation. The corporation includes the $10,000 of dividends in its pre-tax income and its taxable income. For tax purposes, the corporation is entitled to a 70% dividend-received deduction in computing its taxable income. In computing its pre-tax income, however, the corporation simply includes the entire amount of the dividend. This results in a permanent difference of $7,000 between the taxable income and pre-tax income. Formally, this US tax law settlement can also be expressed as: $TI = (1 - \theta_1)PI$ where θ_1 is the pre-tax income dependent relative book-tax difference of 0.7 leading to: $3000 = (1 - 0.7)10{,}000$.

Income independent book-tax differences (i.e., θ_0)

Assume a publicly held corporation pays its CEO a salary of $1.4 million in period t. The salary is not payable on a commission basis and is not performance-based compensation. The salary payment of $1.4 million is an expense on the corporation's income statement; however, for tax purposes the corporation may only deduct $1 million as a result of the limitation for certain excessive employee remuneration under I.R.C. § 162(m). The $400,000 difference between the $1.4 million expense on the income statement and the $1 million deduction on the tax return is a (negative) permanent difference, which enters into the computation of the pre-tax income, but never into taxable income. Assuming that this type of salary is pre-tax income independent, this book-tax difference will be reflected in θ_0 (i.e., $\theta_0 = -400{,}000$). Alternatively stated. As operating income rises and falls from year to year, if the CEO is always paid $1.4 million, the non-deductible portion will not vary with income but will remain stable at $400,000.

Additionally, we note that the use of $NOLs$ in period t is very likely to be independent of pre-tax income in period's t, as they are primarily based on the level of losses reported in prior periods. $NOLs$ will therefore mainly be reflected in θ_0.

[15] These examples are based on those presented in Hanna (2009). See pages 213 and 214.

Table 1: Descriptive Statistics

Panel A: Full Sample

Name	N	mean	sd	min	p25	median	p75	p95	max
CAPX	80,318	0.267	0.194	0.010	0.127	0.214	0.358	0.673	0.968
CASH ETR	81,421	0.171	0.324	-1.000	0.000	0.164	0.344	0.710	1.000
dNOL	74,177	0.019	0.120	-0.322	0.000	0.000	0.000	0.167	0.851
EPS	77,944	0.553	1.981	-8.610	-0.090	0.490	1.310	3.430	7.830
INTAN	72,661	0.130	0.170	0.000	0.000	0.054	0.200	0.509	0.721
LEV	81,099	0.249	0.239	0.000	0.039	0.204	0.378	0.704	1.164
LogAT	81,411	5.493	1.818	2.384	4.067	5.333	6.705	8.810	10.220
MNE	81,421	0.467	0.499	0.000	0.000	0.000	1.000	1.000	1.000
NOL	81,421	0.384	0.486	0.000	0.000	0.000	1.000	1.000	1.000
PI	81,421	97.320	358.100	-339.500	-1.034	7.405	48.010	526.000	2553.000
PPE	81,256	0.272	0.219	0.005	0.101	0.213	0.386	0.748	0.898
PRCCF	74,627	18.230	18.080	0.156	5.000	12.500	25.510	55.660	89.750
ROA	81,411	0.030	0.177	-0.924	-0.011	0.056	0.118	0.238	0.392
SPI	81,411	-0.018	0.060	-0.411	-0.011	0.000	0.000	0.011	0.093
TXPD	81,421	30.370	99.250	-10.790	0.150	2.131	13.350	146.000	717.500
XAD	81,080	0.011	0.027	0.000	0.000	0.000	0.009	0.058	0.178
XRD	81,080	0.053	0.154	0.000	0.000	0.000	0.042	0.223	1.404

CAPX is the total amount spent on capital assets scaled by net property, plant, and equipment (capital expenditures). *Cash ETR* is the ratio of cash taxes paid to current pre-tax income. *dNOL* is the change in net operating losses, scaled by lagged total assets. *EPS* is earnings per share. *INTAN* is intangible assets scaled by the level of total assets. *LEV* is leverage is the current year amount of total debt (*DLTT+DLC*) scaled by total assets. *LogAT* is the natural log of total assets (*AT*) in a given year. *MNE* is an indicator variable for multinational firm-years and is equal to one if the current-year pre-tax foreign income (*PIFO*) is greater than zero of if the absolute vale of the foreign tax expense (*TXFO*) is greater than zero. *NOL* is an indicator variable equal to one if Compustat reports a tax-loss carryforward (*TLCF*) at the end of the previous year, and zero otherwise. *PI* is pre-tax income. *PPE* is the ratio of net property, plant, and equipment to total assets. *PRCCF* is fiscal year end's stock price. *ROA* is return on assets calculated as pre-tax income divided by total assets. *SPI* is computed as the level of special items divided by to total assets; if missing, it is set to zero. *TXPD* is cash taxes paid. *XAD* is the ratio of advertising expense to the level of sales; if missing, it is set to zero. *XRD* is computed as the amount of research and development expense in a given year scaled by the level of sales; if missing, it is set to zero.

Table 1: Descriptive Statistics (continued)

Panel B: Replication of the Dyreng, Hanlon, Maydew, and Thornock, (2017) Sample

Name	N	mean	sd	min	p25	median	p75	p95	max
CAPX	55,901	0.273	0.185	0.010	0.140	0.222	0.359	0.659	0.968
CASH ETR	56,610	0.297	0.232	0.000	0.127	0.276	0.390	0.854	1.000
dNOL	51,414	0.000	0.065	-0.322	0.000	0.000	0.000	0.033	0.851
EPS	54,682	1.292	1.434	-8.610	0.390	0.900	1.690	4.030	7.830
INTAN	50,318	0.130	0.167	0.000	0.000	0.057	0.200	0.500	0.721
LEV	56,410	0.221	0.208	0.000	0.035	0.188	0.341	0.603	1.164
LogAT	56,604	5.692	1.836	2.384	4.279	5.561	6.929	9.049	10.220
MNE	56,610	0.493	0.500	0.000	0.000	0.000	1.000	1.000	1.000
NOL	56,610	0.346	0.476	0.000	0.000	0.000	1.000	1.000	1.000
PI	56,610	152.900	410.400	0.000	5.454	21.040	89.760	770.300	2553.000
PPE	56,501	0.275	0.214	0.005	0.108	0.219	0.383	0.739	0.898
PRCCF	52,343	22.390	18.850	0.156	8.375	17.190	30.750	61.390	89.750
ROA	56,604	0.107	0.080	0.000	0.048	0.089	0.145	0.267	0.392
SPI	56,604	-0.003	0.021	-0.411	-0.003	0.000	0.000	0.012	0.093
TXPD	56,610	41.880	115.400	0.000	0.976	5.010	23.180	222.700	717.500
XAD	56,561	0.011	0.026	0.000	0.000	0.000	0.009	0.058	0.178
XRD	56,561	0.030	0.065	0.000	0.000	0.000	0.030	0.157	1.404

CAPX is the total amount spent on capital assets scaled by net property, plant, and equipment (capital expenditures). *Cash ETR* is the ratio of cash taxes paid to current pre-tax income. *dNOL* is the change in net operating losses, scaled by lagged total assets. *EPS* is earnings per share. *INTAN* is intangible assets scaled by the level of total assets. *LEV* is leverage is the current year amount of total debt (*DLTT+DLC*) scaled by total assets. *LogAT* is the natural log of total assets (*AT*) in a given year. *MNE* is an indicator variable for multinational firm-years and is equal to one if the current-year pre-tax foreign income (*PIFO*) is greater than zero of if the absolute vale of the foreign tax expense (*TXFO*) is greater than zero. *NOL* is an indicator variable equal to one if Compustat reports a tax-loss carryforward (*TLCF*) at the end of the previous year, and zero otherwise. *PI* is pre-tax income. *PPE* is the ratio of net property, plant, and equipment to total assets. *PRCCF* is fiscal year end's stock price. *ROA* is return on assets calculated as pre-tax income divided by total assets. *SPI* is computed as the level of special items divided by to total assets; if missing, it is set to zero. *TXPD* is cash taxes paid. *XAD* is the ratio of advertising expense to the level of sales; if missing, it is set to zero. *XRD* is computed as the amount of research and development expense in a given year scaled by the level of sales; if missing, it is set to zero.

Table 2: Descriptive Statistics

Panel A: Subsample A (Tax Function Type I: $a > 0$, $PI > 0$)

Name	N	mean	sd	min	p25	median	p75	p95	max
CAPX	36,098	0.270	0.187	0.010	0.217	0.357	0.357	0.662	0.968
CASH ETR	36,555	0.286	0.272	-1.000	0.267	0.396	0.396	0.964	1.000
dNOL	33,182	0.000	0.071	-0.322	0.000	0.000	0.000	0.042	0.851
EPS	35,212	1.212	1.411	-8.610	0.820	1.610	1.610	3.870	7.830
INTAN	32,544	0.132	0.166	0.000	0.061	0.206	0.206	0.495	0.721
LEV	36,435	0.230	0.210	0.000	0.199	0.352	0.352	0.617	1.164
LogAT	36,549	5.691	1.858	2.384	5.545	6.925	6.925	9.111	10.220
MNE	36,555	0.524	0.499	0.000	1.000	1.000	1.000	1.000	1.000
NOL	36,555	0.362	0.481	0.000	0.000	1.000	1.000	1.000	1.000
PI	36,555	148.600	414.700	0.000	18.260	80.170	80.170	748.000	2553.000
PPE	36,488	0.266	0.207	0.005	0.213	0.372	0.372	0.710	0.898
PRCCF	33,830	20.950	18.110	0.156	15.800	28.690	28.690	58.470	89.750
ROA	36,549	0.098	0.077	0.000	0.080	0.133	0.133	0.247	0.392
SPI	36,549	-0.003	0.022	-0.411	0.000	0.000	0.000	0.015	0.093
TXPD	36,555	40.000	115.700	-10.790	4.100	19.890	19.890	215.700	717.500
XAD	36,520	0.011	0.026	0.000	0.000	0.010	0.010	0.058	0.178
XRD	36,520	0.032	0.064	0.000	0.000	0.033	0.033	0.163	1.404

CAPX is the total amount spent on capital assets scaled by net property, plant, and equipment (capital expenditures). *Cash ETR* is the ratio of cash taxes paid to current pre-tax income. *dNOL* is the change in net operating losses, scaled by lagged total assets. *EPS* is earnings per share. *INTAN* is intangible assets scaled by the level of total assets. *LEV* is leverage is the current year amount of total debt (*DLTT+DLC*) scaled by total assets. *LogAT* is the natural log of total assets (*AT*) in a given year. *MNE* is an indicator variable for multinational firm-years and is equal to one if the current-year pre-tax foreign income (*PIFO*) is greater than zero of if the absolute vale of the foreign tax expense (*TXFO*) is greater than zero. *NOL* is an indicator variable equal to one if Compustat reports a tax-loss carryforward (*TLCF*) at the end of the previous year, and zero otherwise. *PI* is pre-tax income. *PPE* is the ratio of net property, plant, and equipment to total assets. *PRCCF* is fiscal year end's stock price. *ROA* is return on assets calculated as pre-tax income divided by total assets. *SPI* is computed as the level of special items divided by to total assets; if missing, it is set to zero. *TXPD* is cash taxes paid. *XAD* is the ratio of advertising expense to the level of sales; if missing, it is set to zero. *XRD* is computed as the amount of research and development expense in a given year scaled by the level of sales; if missing, it is set to zero.

Table 2: Descriptive Statistics (continued)

Panel B: Subsample A (Tax Function Type I for high growth Firms: $a > 0$, $PI > 0$, $g > 75$)

Name	N	mean	sd	min	p25	median	p75	p95	max
CAPX	904	0.210	0.109	0.022	0.143	0.192	0.252	0.399	0.968
CASH ETR	912	0.314	0.216	-0.853	0.199	0.295	0.382	0.846	1.000
dNOL	872	0.001	0.032	-0.322	0.000	0.000	0.000	0.028	0.362
EPS	876	2.661	1.961	-8.610	1.300	2.250	3.570	6.970	7.830
INTAN	838	0.152	0.177	0.000	0.008	0.077	0.237	0.563	0.721
LEV	911	0.232	0.149	0.000	0.138	0.211	0.296	0.486	1.164
LogAT	912	9.063	1.038	4.584	8.449	9.289	9.867	10.220	10.220
MNE	912	0.773	0.419	0.000	1.000	1.000	1.000	1.000	1.000
NOL	912	0.404	0.491	0.000	0.000	0.000	1.000	1.000	1.000
PI	912	1220.000	903.600	1.391	410.200	1014.000	2169.000	2553.000	2553.000
PPE	912	0.362	0.221	0.010	0.169	0.316	0.555	0.733	0.898
PRCCF	863	47.660	21.110	2.937	31.000	45.630	61.960	88.990	89.750
ROA	912	0.116	0.069	0.000	0.070	0.105	0.154	0.242	0.392
SPI	912	-0.004	0.018	-0.151	-0.005	0.000	0.000	0.011	0.093
TXPD	912	330.100	255.300	-10.790	106.700	261.000	589.300	717.500	717.500
XAD	912	0.013	0.028	0.000	0.000	0.000	0.013	0.079	0.178
XRD	912	0.025	0.050	0.000	0.000	0.003	0.022	0.143	0.322

CAPX is the total amount spent on capital assets scaled by net property, plant, and equipment (capital expenditures). *Cash ETR* is the ratio of cash taxes paid to current pre-tax income. *dNOL* is the change in net operating losses, scaled by lagged total assets. *EPS* is earnings per share. *INTAN* is intangible assets scaled by the level of total assets. *LEV* is leverage is the current year amount of total debt (*DLTT+DLC*) scaled by total assets. *LogAT* is the natural log of total assets (*AT*) in a given year. *MNE* is an indicator variable for multinational firm-years and is equal to one if the current-year pre-tax foreign income (*PIFO*) is greater than zero of if the absolute vale of the foreign tax expense (*TXFO*) is greater than zero. *NOL* is an indicator variable equal to one if Compustat reports a tax-loss carryforward (*TLCF*) at the end of the previous year, and zero otherwise. *PI* is pre-tax income. *PPE* is the ratio of net property, plant, and equipment to total assets. *PRCCF* is fiscal year end's stock price. *ROA* is return on assets calculated as pre-tax income divided by total assets. *SPI* is computed as the level of special items divided by to total assets; if missing, it is set to zero. *TXPD* is cash taxes paid. *XAD* is the ratio of advertising expense to the level of sales; if missing, it is set to zero. *XRD* is computed as the amount of research and development expense in a given year scaled by the level of sales; if missing, it is set to zero.

Table 3: Descriptive Statistics

Subsample B (Tax Function Type II: $a < 0$, $PI > 0$)

Name	N	mean	sd	min	p25	median	p75	p95	max
CAPX	1,511	0.259	0.182	0.010	0.130	0.216	0.340	0.625	0.968
CASH ETR	1,539	0.192	0.207	-1.000	0.038	0.213	0.328	0.449	1.000
dNOL	1,394	-0.001	0.041	-0.322	0.000	0.000	0.000	0.015	0.851
EPS	1,483	1.596	1.739	-8.610	0.530	1.080	2.030	5.420	7.830
INTAN	1,345	0.119	0.165	0.000	0.000	0.044	0.166	0.502	0.721
LEV	1,518	0.224	0.224	0.000	0.018	0.176	0.367	0.650	1.164
LogAT	1,539	5.763	1.949	2.384	4.257	5.585	7.142	9.603	10.220
MNE	1,539	0.348	0.477	0.000	0.000	0.000	1.000	1.000	1.000
NOL	1,539	0.292	0.455	0.000	0.000	0.000	1.000	1.000	1.000
PI	1,539	226.800	548.700	0.004	7.288	25.490	113.700	1645.000	2553.000
PPE	1,533	0.300	0.234	0.005	0.117	0.234	0.443	0.796	0.898
PRCCF	1,400	26.200	22.340	0.156	10.000	19.020	37.500	77.160	89.750
ROA	1,539	0.133	0.095	0.000	0.062	0.112	0.182	0.334	0.392
SPI	1,539	-0.002	0.017	-0.302	-0.001	0.000	0.000	0.008	0.093
TXPD	1,539	58.560	155.100	-10.790	0.238	3.946	23.060	437.000	717.500
XAD	1,539	0.012	0.029	0.000	0.000	0.000	0.004	0.070	0.178
XRD	1,539	0.021	0.049	0.000	0.000	0.000	0.016	0.135	0.515

CAPX is the total amount spent on capital assets scaled by net property, plant, and equipment (capital expenditures). *Cash ETR* is the ratio of cash taxes paid to current pre-tax income. *dNOL* is the change in net operating losses, scaled by lagged total assets. *EPS* is earnings per share. *INTAN* is intangible assets scaled by the level of total assets. *LEV* is leverage is the current year amount of total debt (*DLTT+DLC*) scaled by total assets. *LogAT* is the natural log of total assets (*AT*) in a given year. *MNE* is an indicator variable for multinational firm-years and is equal to one if the current-year pre-tax foreign income (*PIFO*) is greater than zero of if the absolute vale of the foreign tax expense (*TXFO*) is greater than zero. *NOL* is an indicator variable equal to one if Compustat reports a tax-loss carryforward (*TLCF*) at the end of the previous year, and zero otherwise. *PI* is pre-tax income. *PPE* is the ratio of net property, plant, and equipment to total assets. *PRCCF* is fiscal year end's stock price. *ROA* is return on assets calculated as pre-tax income divided by total assets. *SPI* is computed as the level of special items divided by to total assets; if missing, it is set to zero. *TXPD* is cash taxes paid. *XAD* is the ratio of advertising expense to the level of sales; if missing, it is set to zero. *XRD* is computed as the amount of research and development expense in a given year scaled by the level of sales; if missing, it is set to zero.

Table 4: Descriptive Statistics

Panel A: Subsample C (Tax Function Type III: $a > 0$, $PI < 0$)

Name	N	mean	sd	min	p25	median	p75	p95	max
CAPX	9,284	0.246	0.201	0.010	0.101	0.185	0.334	0.675	0.968
CASH ETR	9,412	-0.146	0.306	-1.000	-0.165	-0.031	-0.002	0.046	1.000
dNOL	8,789	0.062	0.178	-0.322	0.000	0.000	0.061	0.429	0.851
EPS	8,820	-1.549	2.066	-8.610	-1.865	-0.750	-0.280	-0.040	7.830
INTAN	8,492	0.146	0.180	0.000	0.000	0.072	0.229	0.546	0.721
LEV	9,370	0.325	0.294	0.000	0.066	0.271	0.498	0.916	1.164
LogAT	9,416	5.219	1.701	2.384	3.876	5.073	6.384	8.275	10.220
MNE	9,416	0.508	0.500	0.000	0.000	1.000	1.000	1.000	1.000
NOL	9,416	0.476	0.499	0.000	0.000	0.000	1.000	1.000	1.000
PI	9,416	-49.430	85.020	-339.500	-46.270	-13.430	-4.153	-0.607	0.000
PPE	9,407	0.248	0.206	0.005	0.088	0.191	0.351	0.685	0.898
PRCCF	8,453	7.840	9.966	0.156	1.937	4.599	9.750	26.000	89.750
ROA	9,416	-0.157	0.195	-0.924	-0.197	-0.085	-0.032	-0.006	0.000
SPI	9,416	-0.061	0.100	-0.411	-0.080	-0.019	0.000	0.005	0.093
TXPD	9,416	7.835	41.730	-10.790	0.017	0.364	2.640	29.840	717.500
XAD	9,329	0.012	0.029	0.000	0.000	0.000	0.010	0.062	0.178
XRD	9,329	0.090	0.215	0.000	0.000	0.005	0.092	0.374	1.404

CAPX is the total amount spent on capital assets scaled by net property, plant, and equipment (capital expenditures). *Cash ETR* is the ratio of cash taxes paid to current pre-tax income. *dNOL* is the change in net operating losses, scaled by lagged total assets. *EPS* is earnings per share. *INTAN* is intangible assets scaled by the level of total assets. *LEV* is leverage is the current year amount of total debt (*DLTT+DLC*) scaled by total assets. *LogAT* is the natural log of total assets (*AT*) in a given year. *MNE* is an indicator variable for multinational firm-years and is equal to one if the current-year pre-tax foreign income (*PIFO*) is greater than zero of if the absolute vale of the foreign tax expense (*TXFO*) is greater than zero. *NOL* is an indicator variable equal to one if Compustat reports a tax-loss carryforward (*TLCF*) at the end of the previous year, and zero otherwise. *PI* is pre-tax income. *PPE* is the ratio of net property, plant, and equipment to total assets. *PRCCF* is fiscal year end's stock price. *ROA* is return on assets calculated as pre-tax income divided by total assets. *SPI* is computed as the level of special items divided by to total assets; if missing, it is set to zero. *TXPD* is cash taxes paid. *XAD* is the ratio of advertising expense to the level of sales; if missing, it is set to zero. *XRD* is computed as the amount of research and development expense in a given year scaled by the level of sales; if missing, it is set to zero.

Table 4: Descriptive Statistics (continued)

Panel B: Subsample D (Tax Function Type IV: $a < 0$, $PI < 0$)

Name	N	mean	sd	min	p25	median	p75	p95	max
CAPX	106	0.200	0.217	0.010	0.064	0.125	0.236	0.769	0.968
CASH ETR	106	0.063	0.237	-0.389	0.000	0.000	0.000	0.627	1.000
dNOL	94	0.176	0.322	-0.322	0.000	0.000	0.282	0.851	0.851
EPS	97	-1.997	2.781	-8.610	-2.390	-0.640	-0.250	-0.050	0.090
INTAN	103	0.110	0.190	0.000	0.000	0.003	0.144	0.632	0.721
LEV	106	0.430	0.372	0.000	0.117	0.354	0.621	1.164	1.164
LogAT	106	4.638	1.471	2.384	3.626	4.358	5.704	7.043	8.246
MNE	106	0.094	0.294	0.000	0.000	0.000	0.000	1.000	1.000
NOL	106	0.557	0.499	0.000	0.000	1.000	1.000	1.000	1.000
PI	106	-34.230	60.400	-339.500	-33.960	-16.690	-7.017	-2.013	-0.033
PPE	106	0.361	0.246	0.005	0.195	0.298	0.516	0.858	0.898
PRCCF	90	7.201	9.706	0.156	1.600	4.688	9.000	21.250	65.000
ROA	106	-0.323	0.333	-0.924	-0.546	-0.197	-0.047	-0.013	0.000
SPI	106	-0.041	0.094	-0.411	-0.038	0.000	0.000	0.019	0.093
TXPD	106	-0.233	4.841	-10.790	0.000	0.000	0.004	2.461	35.200
XAD	103	0.010	0.022	0.000	0.000	0.000	0.009	0.048	0.118
XRD	103	0.165	0.417	0.000	0.000	0.000	0.013	1.404	1.404

CAPX is the total amount spent on capital assets scaled by net property, plant, and equipment (capital expenditures). *Cash ETR* is the ratio of cash taxes paid to current pre-tax income. *dNOL* is the change in net operating losses, scaled by lagged total assets. *EPS* is earnings per share. *INTAN* is intangible assets scaled by the level of total assets. *LEV* is leverage is the current year amount of total debt (*DLTT+DLC*) scaled by total assets. *LogAT* is the natural log of total assets (*AT*) in a given year. *MNE* is an indicator variable for multinational firm-years and is equal to one if the current-year pre-tax foreign income (*PIFO*) is greater than zero of if the absolute vale of the foreign tax expense (*TXFO*) is greater than zero. *NOL* is an indicator variable equal to one if Compustat reports a tax-loss carryforward (*TLCF*) at the end of the previous year, and zero otherwise. *PI* is pre-tax income. *PPE* is the ratio of net property, plant, and equipment to total assets. *PRCCF* is fiscal year end's stock price. *ROA* is return on assets calculated as pre-tax income divided by total assets. *SPI* is computed as the level of special items divided by to total assets; if missing, it is set to zero. *TXPD* is cash taxes paid. *XAD* is the ratio of advertising expense to the level of sales; if missing, it is set to zero. *XRD* is computed as the amount of research and development expense in a given year scaled by the level of sales; if missing, it is set to zero.

Table 5

Panel A: Results on H1 (Tax Function Type I: PI > 0, a > 0)

Variable	Coefficient	t-statistic	p-value
Intercept	11.28622***	8.84	0.00
PI	0.193749***	19.86	0.00
R^2			0.9459
N			25

Panel B: Results on H1 for high growth Firms (Tax Function Type I: PI > 0; a > 0; g > 75)

Variable	Coefficient	t-statistic	p-value
Intercept	88.37807***	9.46	0.00
PI	0.197965***	26.73	0.00
R^2			0.9603
N			25

Panel C: Results on H1 based on the DHMT, (2017) sample

Variable	Coefficient	t-statistic	p-value
Intercept	6.65013***	6.93	0.00
PI	0.23066***	33.96	0.00
R^2			0.9763
N			25

Panel D: Results on H2 (Tax Function Type II: PI > 0; a < 0)

Variable	Coefficient	t-statistic	p-value
Intercept	-4.65128***	-4.94	0.00
PI	0.27882***	73.59	0.00
R^2			0.9943
N			25

Panel E: Results on Tax Function Type III: (PI < 0; a > 0)

Variable	Coefficient	t-statistic	p-value
Intercept	3.24918***	2.10	0.00
PI	-0.09809***	-3.36	0.05
R^2			0.9459
N			25

This table present the results from estimating equation (13), i.e., regressing the annual means of cash taxes paid ($TXPD$) on the annual means of pre-tax income (PI) for various subsamples based on pre-tax income, growth, and the estimated intercepts from firm specific regressions. ***, **, and * denote statistical significance at the 0.01, 0.05, and 0.10 level respectively.

Table 6

Panel A: Pooled Regression Results on H1 based on the DHMT (2017) sample

VARIABLES	(1) *TXPD(t)*	(2) *TXPD(t)*	(3) *TXPD(t)*	(4) *TXPD(t)*
PI(t)	0.214***	0.236***	0.204***	0.197***
	(40.86)	(12.82)	(10.36)	(9.54)
*PI(t)*Trend*		0.00163***	-0.000350	-0.000282
		(3.73)	(-0.79)	(-0.60)
PI(t-1)			0.0709***	0.0613***
			(8.91)	(7.94)
PI(t-2)			0.0311***	0.0421***
			(4.67)	(6.03)
PI(t-3)			0.0156***	
			(2.81)	
*MNE(t)*PI(t)*		-0.0286***	-0.0314***	-0.0290***
		(-3.36)	(-3.61)	(-3.27)
*XRD(t)*PI(t)*		-0.170**	-0.264***	-0.272***
		(-2.34)	(-3.10)	(-2.99)
*PPE(t)*PI(t)*		-0.0298	-0.0491**	-0.0420*
		(-1.16)	(-1.97)	(-1.66)
*INTAN(t)*PI(t)*		-0.0148	-0.0328	-0.0352
		(-0.69)	(-1.61)	(-1.62)
*LEV(t)*PI(t)*		-0.0386*	-0.0158	-0.00194
		(-1.83)	(-0.86)	(-0.09)
*CAPX(t)*PI(t)*		0.0338	0.0133	0.0235
		(0.97)	(0.40)	(0.68)
*XAD(t)*PI(t)*		-0.120	-0.222**	-0.215**
		(-1.05)	(-2.13)	(-1.96)
*SPI(t)*PI(t)*		-0.739***	-0.340***	-0.329***
		(-6.41)	(-3.16)	(-2.95)
*SPI(t-1)*PI(t)*		0.222**	0.133	0.107
		(2.19)	(1.20)	(1.08)
*NOL(t)*PI(t)*		-0.00481	-0.00222	-0.00283
		(-0.76)	(-0.35)	(-0.41)
*dNOL(t)*PI(t)*		0.00559	0.0304	0.0307
		(0.12)	(0.48)	(0.74)
PI(t+1)				0.0122*
				(1.91)
Constant	9.209***	11.57***	7.963***	6.985***
	(11.52)	(10.48)	(4.95)	(4.41)
Observations	56,610	38,669	24,896	24,698
Number of Firms	6,182	5,464	4,039	4,027
Adj. R-squared	0.58	0.61	0.64	0.65
Firm Fixed Effects	Yes	Yes	Yes	Yes

Panel B: Pooled Regression Results on H1 (Tax Function Type I: PI > 0, a > 0)

VARIABLES	(1) *TXPD(t)*	(2) *TXPD(t)*	(3) *TXPD(t)*	(4) *TXPD(t)*
PI(t)	0.174***	0.132***	0.105***	0.109***
	(22.51)	(5.88)	(4.13)	(4.11)
*PI(t)*Trend*		0.00170***	-0.000195	-0.000254
		(3.08)	(-0.34)	(-0.42)
PI(t-1)			0.0729***	0.0672***
			(8.98)	(8.64)
PI(t-2)			0.0353***	0.0362***
			(4.22)	(4.90)
PI(t-3)			0.00587	
			(0.70)	
*MNE(t)*PI(t)*		-0.0378***	-0.0350***	-0.0395***
		(-3.66)	(-3.74)	(-3.76)
*XRD(t)*PI(t)*		-0.117	-0.158	-0.156
		(-1.02)	(-1.37)	(-1.26)
*PPE(t)*PI(t)*		0.0817**	0.0613*	0.0573*
		(2.45)	(1.88)	(1.68)
*INTAN(t)*PI(t)*		0.0375	0.0285	0.0371
		(1.34)	(1.14)	(1.34)
*LEV(t)*PI(t)*		-0.0357	-0.0355	-0.0228
		(-1.47)	(-1.54)	(-0.88)
*CAPX(t)*PI(t)*		0.174***	0.133***	0.137***
		(5.43)	(4.17)	(4.33)
*XAD(t)*PI(t)*		-0.142	-0.183	-0.178
		(-0.80)	(-1.13)	(-1.03)
*SPI(t)*PI(t)*		-0.710***	-0.395***	-0.378***
		(-6.13)	(-3.35)	(-3.10)
*SPI(t-1)*PI(t)*		0.0903	0.0495	0.0354
		(0.91)	(0.45)	(0.30)
*NOL(t)*PI(t)*		-0.00111	-0.000181	-0.000498
		(-0.16)	(-0.03)	(-0.07)
*dNOL(t)*PI(t)*		0.00908	0.0463	-0.00184
		(0.23)	(0.75)	(-0.04)
PI(t+1)				0.0115
				(1.46)
Constant	14.12***	16.82***	14.54***	13.14***
	(12.28)	(11.25)	(6.16)	(5.31)
Observations	36,555	24,503	15,060	14,957
Number of Firms	3,974	3,548	2,540	2,542
Adj. R-squared	0.44	0.52	0.56	0.57
Firm Fixed Effects	Yes	Yes	Yes	Yes

Panel C: Pooled Regression Results on H2 (Tax Function Type II: PI > 0, a < 0)

VARIABLES	(1) *TXPD(t)*	(2) *TXPD(t)*	(3) *TXPD(t)*	(4) *TXPD(t)*
PI(t)	0.304***	0.331***	0.336***	0.329***
	(18.27)	(8.32)	(8.62)	(9.51)
*PI(t)*Trend*		0.000190	-0.000199	0.000307
		(0.24)	(-0.19)	(0.33)
PI(t-1)			0.00295	-0.00552
			(0.10)	(-0.15)
PI(t-2)			0.0191	0.0448
			(0.67)	(1.33)
PI(t-3)			0.0216	
			(0.62)	
*MNE(t)*PI(t)*		0.0198	0.0196	0.0259
		(0.51)	(0.53)	(0.79)
*XRD(t)*PI(t)*		-0.143	0.00858	0.0155
		(-0.93)	(0.06)	(0.10)
*PPE(t)*PI(t)*		-0.166***	-0.176***	-0.0754
		(-3.17)	(-3.77)	(-1.44)
*INTAN(t)*PI(t)*		-0.0672**	-0.0738**	-0.0852**
		(-2.01)	(-2.51)	(-2.39)
*LEV(t)*PI(t)*		-0.0223	-0.0183	0.00959
		(-0.57)	(-0.50)	(0.32)
*CAPX(t)*PI(t)*		0.00862	0.00935	-0.0536
		(0.16)	(0.19)	(-1.66)
*XAD(t)*PI(t)*		-0.222	-0.408*	-0.396***
		(-1.51)	(-1.93)	(-3.39)
*SPI(t)*PI(t)*		-0.392	-0.274	-0.373
		(-1.12)	(-0.89)	(-1.18)
*SPI(t-1)*PI(t)*		-0.175	-0.194**	-0.100
		(-1.24)	(-2.09)	(-1.46)
*NOL(t)*PI(t)*		-0.00305	-0.0212**	-0.00476
		(-0.31)	(-2.03)	(-0.67)
*dNOL(t)*PI(t)*		0.254**	0.148	0.0792
		(2.25)	(1.13)	(0.67)
PI(t+1)				-0.0434**
				(-2.59)
Constant	-10.30***	-6.721*	-16.23***	-8.320
	(-2.73)	(-1.90)	(-3.18)	(-1.64)
Observations	1,539	1,135	865	854
Number of Firms	151	132	122	121
Adj. R-squared	0.87	0.86	0.85	0.87
Firm Fixed Effects	Yes	Yes	Yes	Yes

Panel D: Pooled Regression Results on the Full Sample

VARIABLES	(1) *TXPD(t)*	(2) *TXPD(t)*	(3) *TXPD(t)*	(4) *TXPD(t)*
PI(t)	0.173***	0.175***	0.165***	0.149***
	(29.65)	(9.54)	(10.06)	(8.64)
*PI(t)*Trend*		0.00282***	0.000184	0.000321
		(5.71)	(0.41)	(0.66)
PI(t-1)			0.0716***	0.0691***
			(15.82)	(14.82)
PI(t-2)			0.0318***	0.0461***
			(9.14)	(11.85)
PI(t-3)			0.0258***	
			(6.12)	
*MNE(t)*PI(t)*		-0.0252**	-0.0285***	-0.0265***
		(-2.35)	(-2.91)	(-2.71)
*XRD(t)*PI(t)*		-0.196***	-0.180***	-0.171***
		(-3.96)	(-4.13)	(-3.73)
*PPE(t)*PI(t)*		-0.0224	-0.0308	-0.0250
		(-0.79)	(-1.23)	(-0.95)
*INTAN(t)*PI(t)*		3.37e-05	-0.0113	-0.0112
		(0.00)	(-0.54)	(-0.50)
*LEV(t)*PI(t)*		-0.116***	-0.0825***	-0.0761***
		(-4.80)	(-4.15)	(-3.64)
*CAPX(t)*PI(t)*		0.0486	0.0121	0.0105
		(1.47)	(0.44)	(0.35)
*XAD(t)*PI(t)*		-0.106	-0.286**	-0.247*
		(-0.75)	(-2.28)	(-1.86)
*SPI(t)*PI(t)*		0.0367	0.0755*	0.0542
		(0.64)	(1.71)	(1.17)
*SPI(t-1)*PI(t)*		-0.0631	0.0999**	0.0765*
		(-1.53)	(2.49)	(1.85)
*NOL(t)*PI(t)*		-0.00791	-0.00441	-0.00649
		(-1.10)	(-0.72)	(-0.98)
*dNOL(t)*PI(t)*		-0.0134	-0.00668	-0.0107
		(-0.23)	(-0.19)	(-0.34)
PI(t+1)				0.0188***
				(4.51)
Constant	13.49***	15.34***	9.490***	9.356***
	(23.70)	(23.65)	(12.78)	(12.80)
Observations	81,421	65,114	53,513	53,014
Number of Firms	6,452	6,254	6,156	6,153
Adj. R-squared	0.47	0.48	0.56	0.56
Firm Fixed Effects	Yes	Yes	Yes	Yes

Robust t-statistics in parentheses *** p<0.01, ** p<0.05, * p<0.1. All variables are as defined in Tables 1-4.

Table 7: Multinationals and Purely Domestic Firms

Panel A: Pooled Regression Results on Multinationals

VARIABLES	(1) *TXPD(t)*	(3) *TXPD(t)*	(4) *TXPD(t)*	(5) *TXPD(t)*
PI(t)	0.212***	0.197***	0.175***	0.166***
	(31.95)	(8.75)	(7.32)	(6.78)
*PI(t)*Trend*		0.000785	-0.000470	-0.000875
		(1.54)	(-0.89)	(-1.58)
PI(t-1)			0.0552***	0.0724***
			(4.84)	(6.19)
PI(t-2)			0.0359***	0.0340***
			(3.64)	(3.81)
PI(t-3)			0.00537	
			(0.63)	
*XRD(t)*PI(t)*		-0.0446	-0.162	-0.130
		(-0.50)	(-1.52)	(-1.21)
*PPE(t)*PI(t)*		0.00558	-0.0320	-0.0345
		(0.16)	(-0.83)	(-0.83)
*INTAN(t)*PI(t)*		-0.00351	-0.0300	-0.0220
		(-0.16)	(-1.32)	(-0.96)
*LEV(t)*PI(t)*		-0.0246	-0.0111	-0.00852
		(-0.95)	(-0.43)	(-0.31)
*CAPX(t)*PI(t)*		0.0587	0.0350	0.0373
		(1.17)	(0.59)	(0.72)
*XAD(t)*PI(t)*		-0.115	-0.214	-0.199
		(-0.85)	(-1.59)	(-1.45)
*SPI(t)*PI(t)*		-0.638***	-0.362***	-0.364***
		(-5.73)	(-2.80)	(-2.76)
*SPI(t-1)*PI(t)*		0.308**	0.287*	0.193
		(2.51)	(1.96)	(1.52)
*NOL(t)*PI(t)*		-0.00147	-0.00154	0.000858
		(-0.20)	(-0.19)	(0.10)
*dNOL(t)*PI(t)*		0.0638	0.0484	0.0653
		(1.19)	(0.72)	(1.44)
PI(t+1)				0.0104
				(0.93)
Constant	16.23***	19.48***	15.05***	10.32**
	(7.53)	(6.40)	(3.11)	(2.11)
Observations	17,357	11,590	7,252	6,859
Number of Firms	2,539	2,078	1,417	1,332
Adj. R-squared	0.54	0.57	0.57	0.60
Firm Fixed Effects	Yes	Yes	Yes	Yes

Robust t-statistics in parentheses *** p<0.01, ** p<0.05, * p<0.1. All variables are as defined in Tables 1-4.

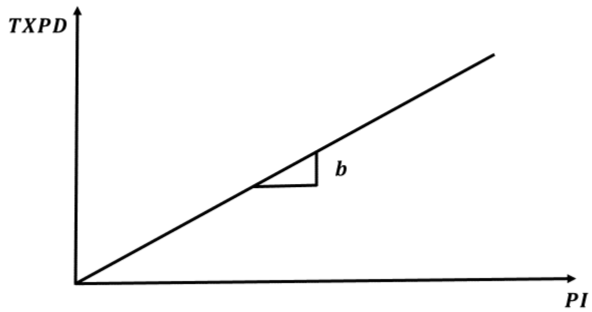
Panel B: Pooled Regression Results on Domestics

VARIABLES	(1) *TXPD(t)*	(3) *TXPD(t)*	(4) *TXPD(t)*	(5) *TXPD(t)*
PI(t)	0.248***	0.358***	0.317***	0.324***
	(20.81)	(8.48)	(7.66)	(7.73)
*PI(t)*Trend*		0.00158	-0.000262	-0.000112
		(1.19)	(-0.15)	(-0.06)
PI(t-1)			0.0808***	0.0261
			(2.64)	(0.94)
PI(t-2)			0.0226	0.00760
			(1.23)	(0.36)
PI(t-3)			-0.0108	
			(-0.96)	
*XRD(t)*PI(t)*		-0.332***	-0.303	-0.295
		(-2.77)	(-0.80)	(-0.89)
*PPE(t)*PI(t)*		-0.187***	-0.167***	-0.0925**
		(-3.96)	(-3.80)	(-2.26)
*INTAN(t)*PI(t)*		-0.109***	-0.128***	-0.104***
		(-2.79)	(-3.36)	(-3.09)
*LEV(t)*PI(t)*		-0.0683**	-0.0577	-0.0504
		(-2.14)	(-1.42)	(-1.19)
*CAPX(t)*PI(t)*		-0.0878*	-0.0923**	-0.0443
		(-1.71)	(-2.07)	(-0.90)
*XAD(t)*PI(t)*		0.595	0.367	0.159
		(1.44)	(0.87)	(0.41)
*SPI(t)*PI(t)*		-1.090**	-0.535	-0.737
		(-2.49)	(-1.02)	(-0.92)
*SPI(t-1)*PI(t)*		0.982*	0.576	0.842
		(1.90)	(1.03)	(1.27)
*NOL(t)*PI(t)*		-0.0144	-0.00379	-0.0108
		(-0.99)	(-0.24)	(-0.53)
*dNOL(t)*PI(t)*		0.0996	0.0438	-0.0745
		(0.65)	(0.46)	(-0.32)
PI(t+1)				-0.00297
				(-0.22)
Constant	2.033***	2.532**	1.220	1.746
	(2.93)	(2.46)	(0.78)	(1.06)
Observations	28,079	18,210	10,810	11,133
Number of Firms	4,345	3,491	2,273	2,352
Adj. R-squared	0.65	0.71	0.73	0.75
Firm Fixed Effects	Yes	Yes	Yes	Yes

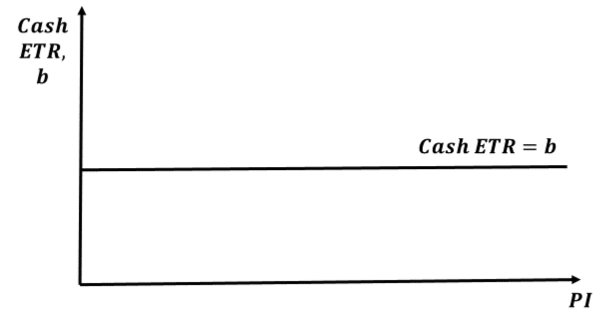
Robust t-statistics in parentheses *** p<0.01, ** p<0.05, * p<0.1. All variables are as defined in Tables 1-4.

Figure 1: The Relation between Corporate Tax Functions and Tax Avoidance

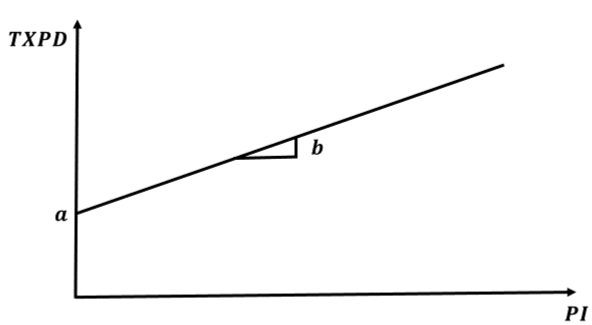
1(A) Proportional Tax Function: No Tax Avoidance



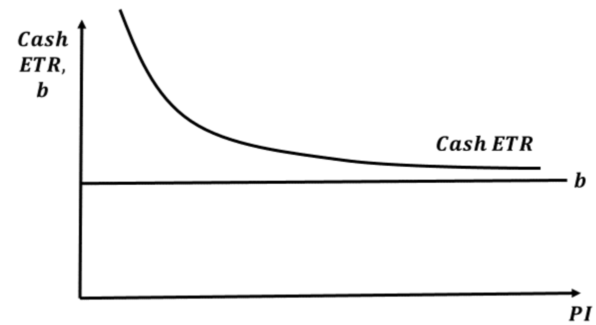
1(B) Proportional Tax Function: No Tax Avoidance



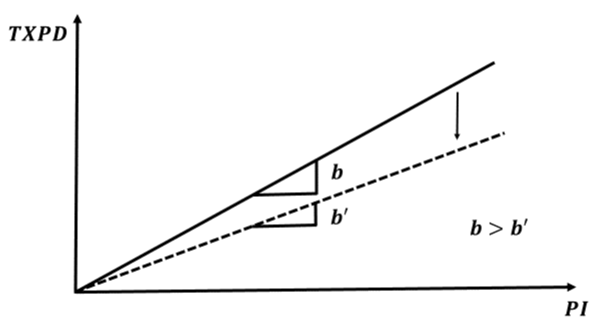
1(C) Linear Tax Function: No Tax Avoidance



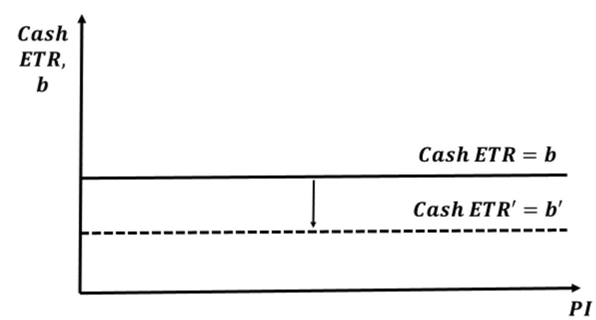
1(D) Linear Tax Function: No Tax Avoidance



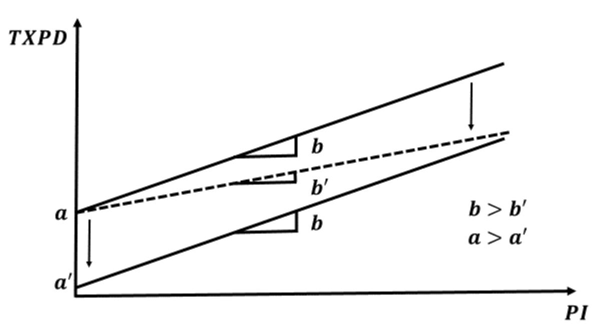
1(E) Proportional Tax Function: With Tax Avoidance



1(F) Proportional Tax Function: With Tax Avoidance



1(G) Linear Tax Function: With Tax Avoidance



1(H) Linear Tax Function: With Tax Avoidance

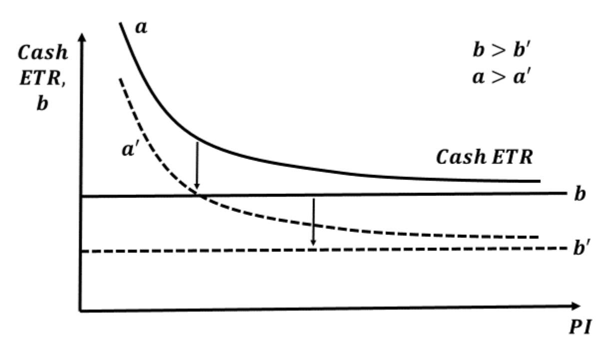
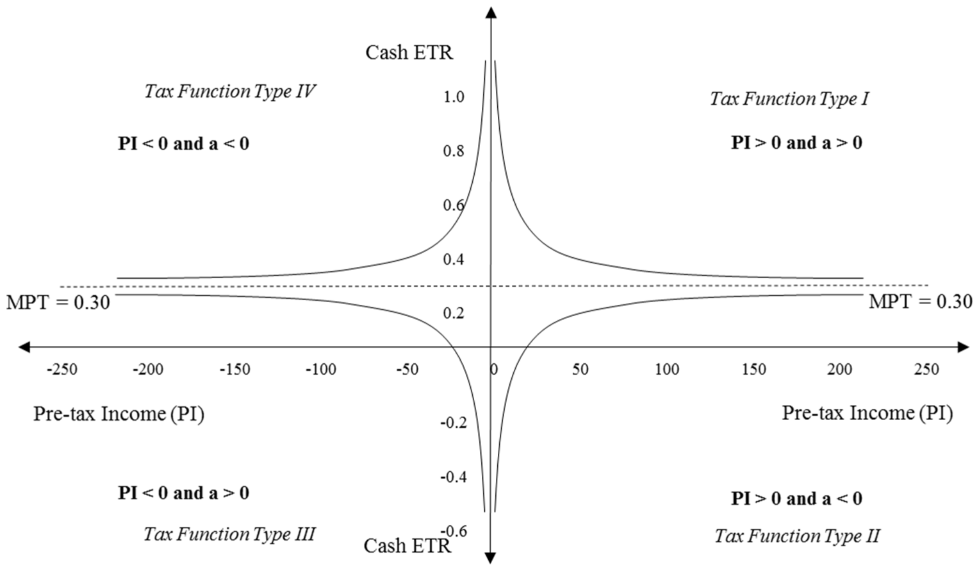


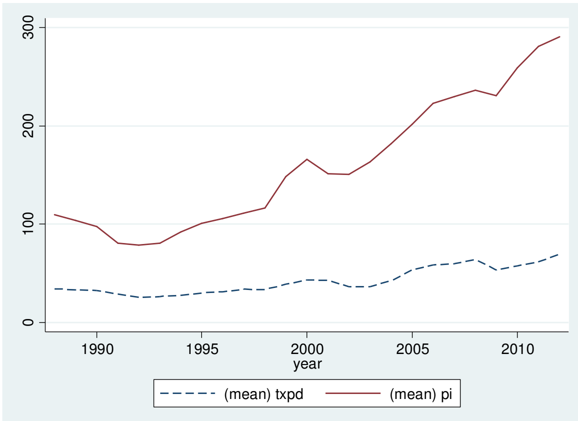
Figure 2: Associations between average Cash ETRs and the marginal propensity to tax (MPT) for tax function types I to IV



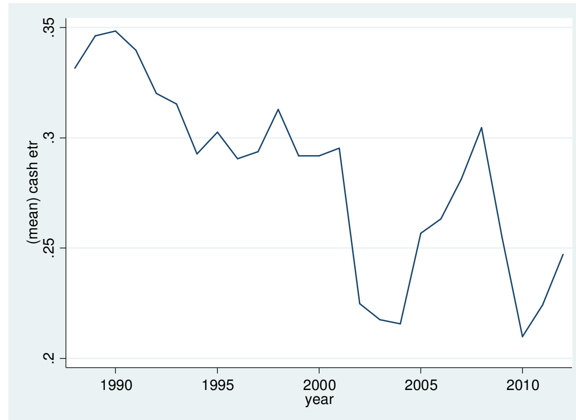
This figure illustrates the relations between the magnitudes of Cash ETRs and the marginal propensity to tax (MPT=0.30) as a function of a and PI_t, i.e.: $Cash\ ETR_t = \frac{TXPD_t}{PI_t} = \frac{a}{PI_t} + b$ for the following four types of tax functions: *Type I*: $PI_t > 0$ and $a > 0$; *Type II*: $PI_t > 0$ and $a < 0$; *Type III*: $PI_t < 0$ and $a > 0$; *Type IV*: $PI_t < 0$ and $a < 0$.

Figure 3: Empirical Results on H1 (Tax Function Type I)

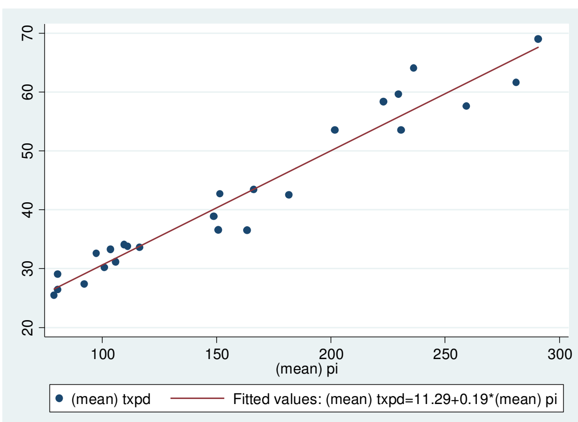
3(A) Evolution of the mean pre-tax income and mean cash taxes paid over time



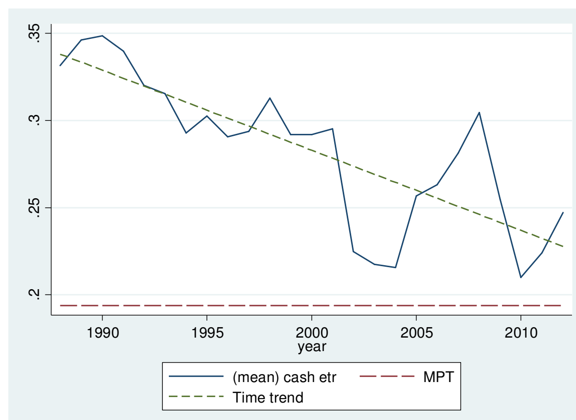
3(B) Evolution of the mean Cash ETR over time



3(C) Scatter diagram of mean TXPD on mean PI



3(D) Association between mean Cash ETR and MPT



3(E) Evolution of the mean residual TXPD over time

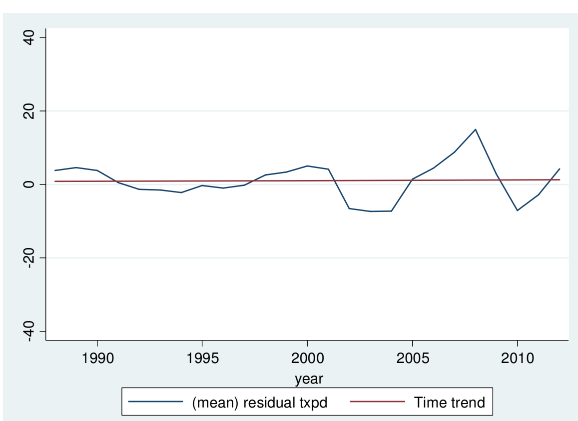
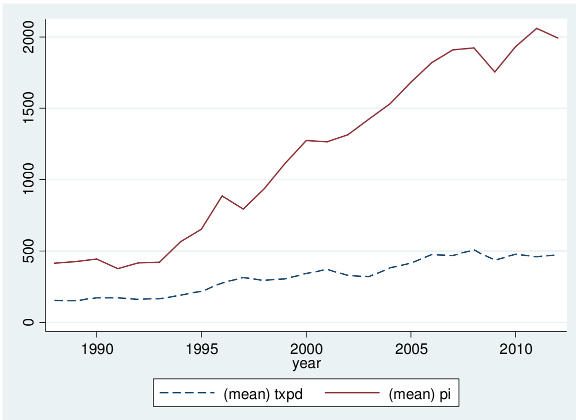
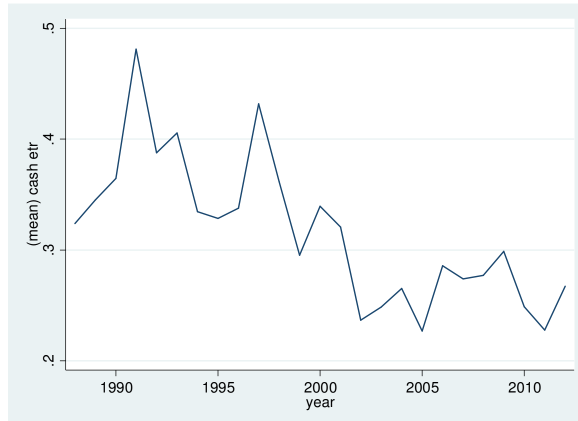


Figure 4: Empirical Results on H1 (Tax Function Type I for high growth Firms)

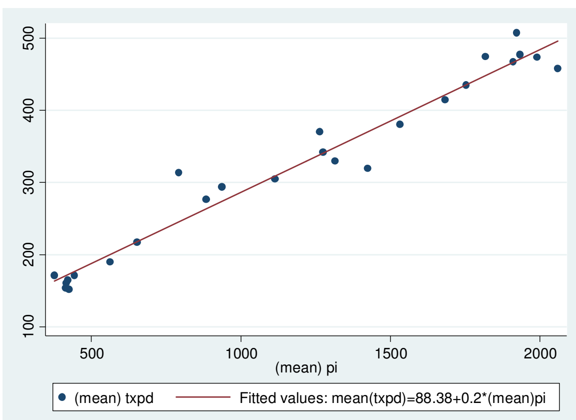
4(A) Evolution of the mean pre-tax income and mean cash taxes paid over time



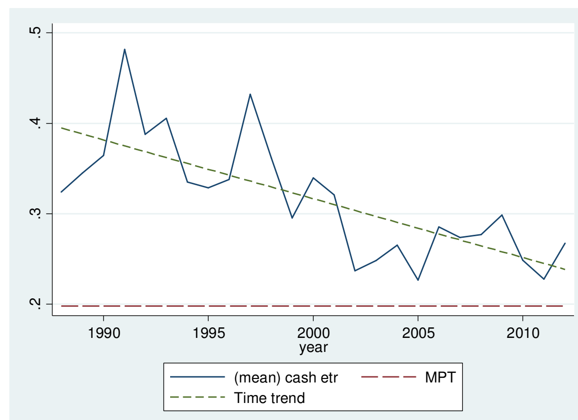
4(B) Evolution of the mean Cash ETR over time



4(C) Scatter diagram of mean TXPD on mean PI



4(D) Association between mean Cash ETR and MPT



4(E) Evolution of the mean residual TXPD over time

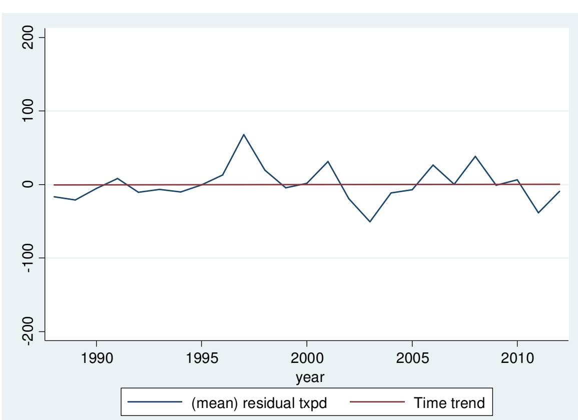
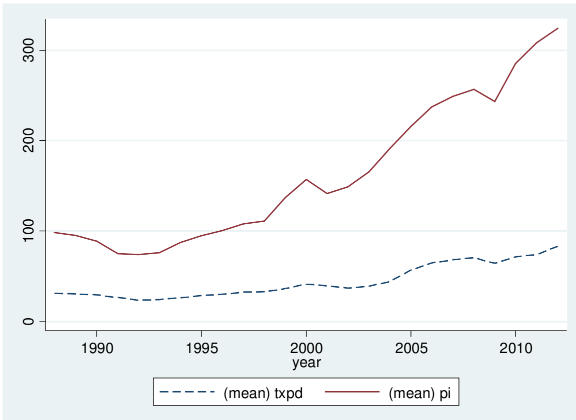
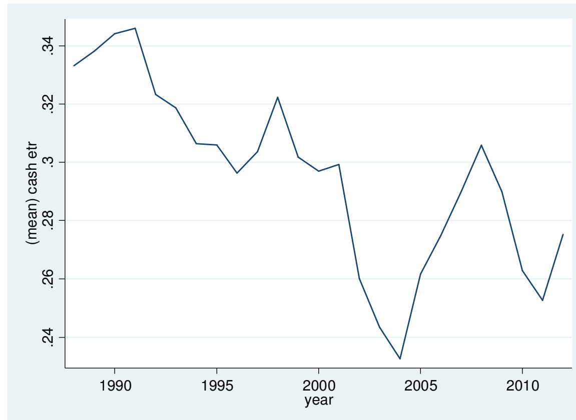


Figure 5: Empirical Results on H1 based on the DHMT (2017) sample

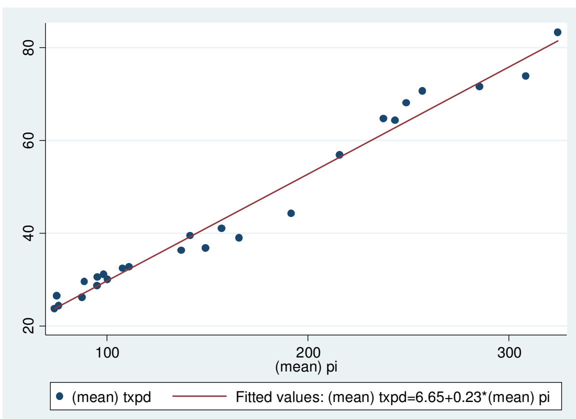
5(A) Evolution of the mean pre-tax income and mean cash taxes paid over time



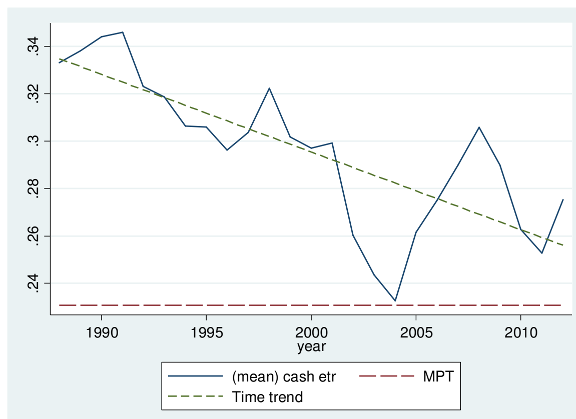
5(B) Evolution of the mean Cash ETR over time



5(C) Scatter diagram of mean TXPD on mean PI



5(D) Association between mean Cash ETR and MPT



5(E) Evolution of the mean residual TXPD over time

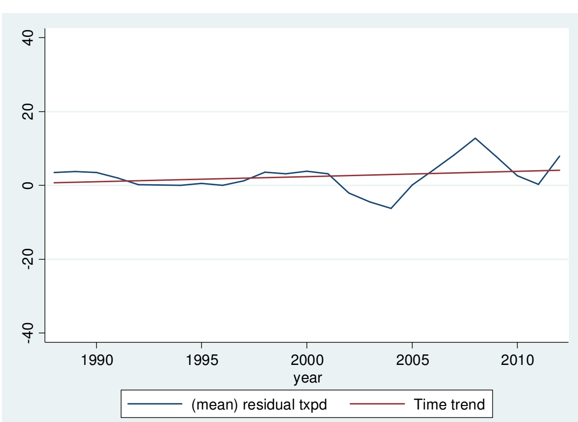
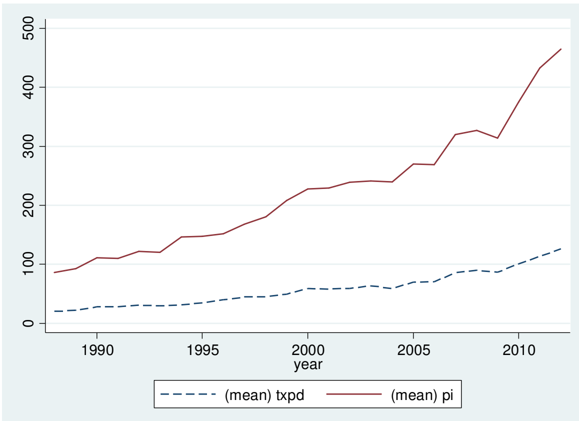
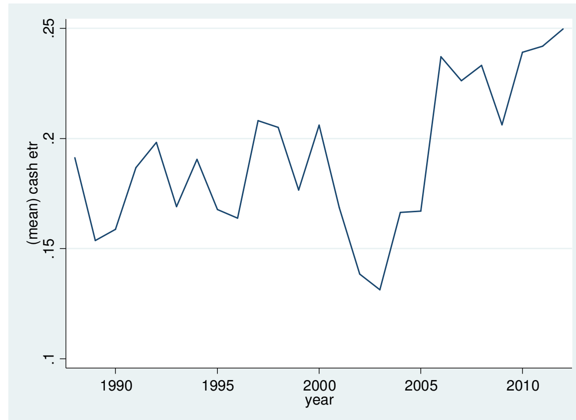


Figure 6: Empirical Results on H2 (Tax Function Type II)

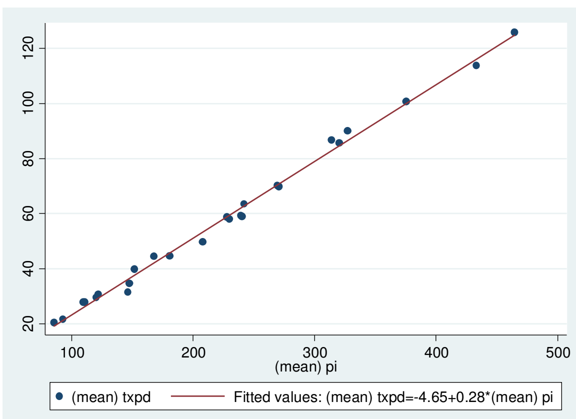
6(A) Evolution of the mean pre-tax income and mean cash taxes paid over time



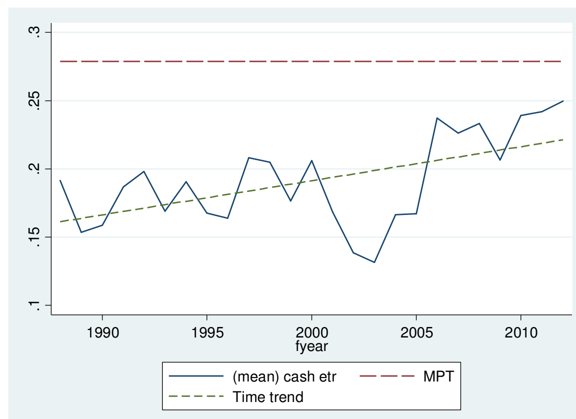
6(B) Evolution of the mean Cash ETR over time



6(C) Scatter diagram of mean TXPD on mean PI



6(D) Association between mean Cash ETR and MPT



6(E) Evolution of the mean residual TXPD over time

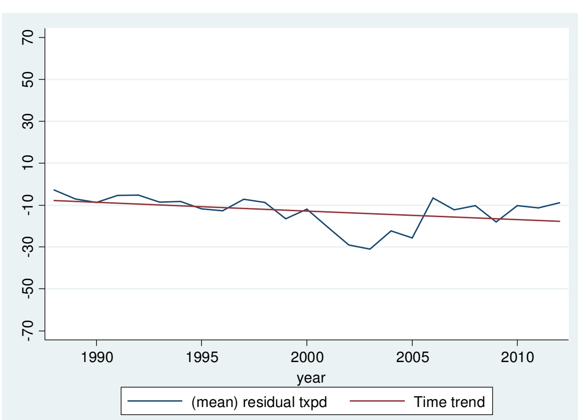
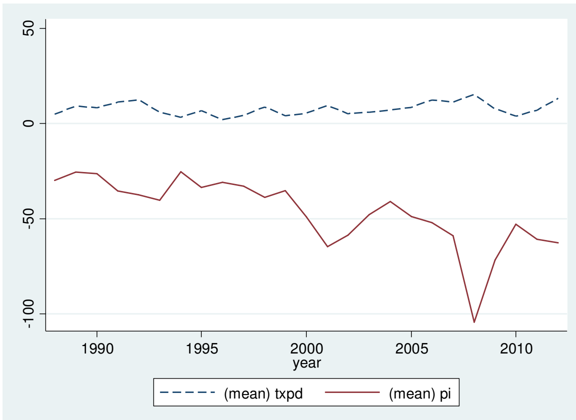
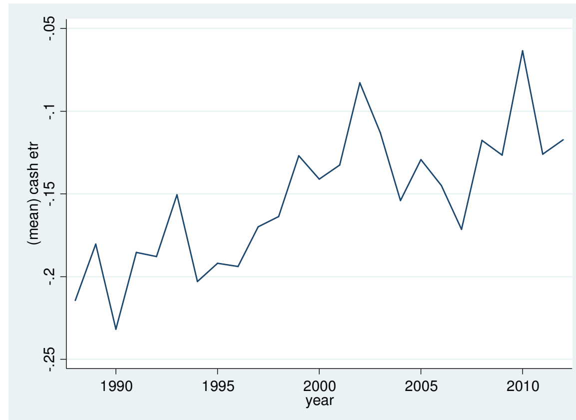


Figure 7: Empirical Results on Tax Function Type III

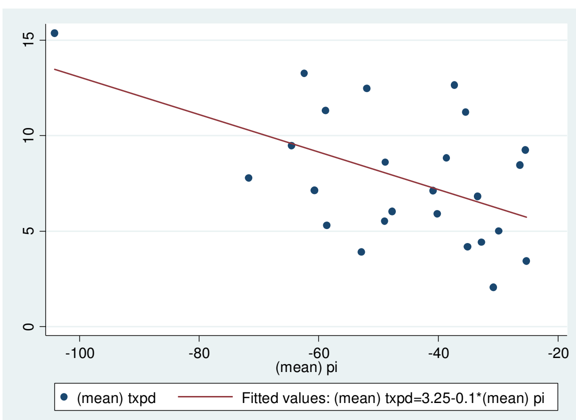
7(A) Evolution of the mean pre-tax income and mean cash taxes paid over time



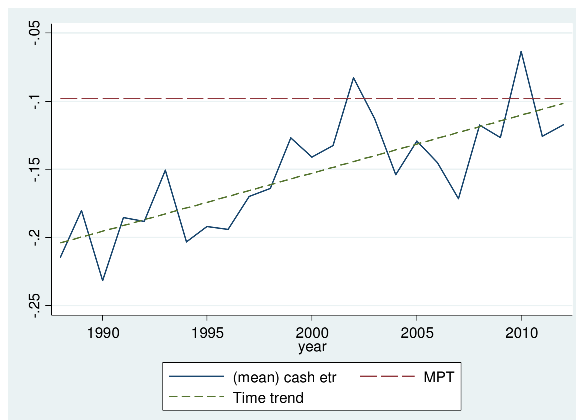
7(B) Evolution of the mean Cash ETR over time



7(C) Scatter diagram of mean TXPD on mean PI



7(D) Association between mean Cash ETR and MPT



7(E) Evolution of the mean residual TXPD over time