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CAPITAL INCOME TAXATION INCENTIVES DURING ECONOMIC DOWNTURNS: RE-THINKING THEORY AND EVIDENCE

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Capital income taxation incentives during economic downturns: re-thinking theory and evidence

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Abstract

This paper studies the effectiveness of corporate tax incentives in reducing the effective tax rate (ETR) on income from capital to stimulate business investment during economic downturns. We focus on tax rate incentives (TRIs), such as corporate tax rate cuts, and tax base incentives (TBIs), such as increased capital allowances. The standard economic theory states that TRIs reduce the ETR by decreasing tax payments on corporate profits. TBIs instead reduce the ETR as they defer firms' tax payments, in turn increasing the present value of dividend distribution. However, this theory does not consider that, in reality, firms face accounting constraints preventing any distribution of cash flows arising from TBIs. For this reason, the standard economic analysis overstates the benefit of any TBI relative to that of TRIs. The paper incorporates accounting constraints on dividend policy into the model for the computation of the ETR and employs the new model to recalculate ETRs in the US and in the UK during 1980-2010. The empirical results confirm that the benefit of TBIs is significantly overstated by the standard theory, and tax rate cuts are more effective in reducing the ETR. We show that this result holds regardless of the form of investment finance (retained earning, new equity and debt), the type capital asset (building and plant and machinery), the level of capital income taxation (corporate and shareholders), and the value of accounting depreciation relative to economic depreciation.

Keywords: Capital income taxation; dividend policy; effective marginal tax rates; financial constraints.

JEL classification: H3.

1 Introduction

Over the last thirty years, both the United States and United Kingdom have relied on a number of tax incentives to stimulate business investment, capital accumulation and faster growth during periods of economic downturn or recovery. The principle underpinning a policy based on the provision of a tax incentive is a well established one in the economic theory: tax incentives reduce the effective tax burden on income from capital in turn increasing the after tax rate of return from investment. This increase in return should then raise demand for capital goods. The focus of this paper is to evaluate which type of tax incentive is more effective in reducing the tax burden on income from capital.[1] A very different range of tax incentives has been employed in the United States and in the United Kingdom over the last 30 years. We narrow the scope of our analysis to generic and economy-wide tax incentives granted to domestic corporate investors regardless of any specific characteristic of the business, such as its location, size, or type. Within these margins, a lower effective tax burden on income from capital can be achieved either through a reduction of the statutory tax rate levied on capital income at both corporate or personal level (tax rate incentive, hereafter TRI) or, given the headline tax rate, through a reduction of the corporate tax base (tax base incentive, hereafter TBI). The key issue we investigate in the paper is which of the two types of incentives, TRI or TBI, is more effective in reducing the tax burden on income from capital.

Following the standard economic literature started by King and Fullerton (1984), and then further developed by Devereux and Griffith (1998b, 2003), we measure the tax burden on business investment through the effective tax rate (ETR) on income from capital. There are two main reasons for choosing the ETR proposed in this literature as the indicator of the effective tax burden on income from capital against which to compare the impact of TRIs and TBI. First, ETRs are widely employed by policy makers for cross-country comparisons of the corporate tax burden and assessment of capital income taxation systems.[2] Second, ETRs are particularly useful to evaluate and compare the effectiveness of TRIs relative to TBIs, since they represent simple indicators which take into account simultaneously how tax rates and tax base rules determine the overall tax burden on income from capital. Of course, tax codes set a large number of rules for the determination of the tax base, which cannot be taken simultaneously into account by a single indicator. We follow the standard corporate tax literature and therefore focus only on tax depreciation allowances for capital spending: as a result, we consider as TBI an increase in the rate of tax depreciation allowances.

[1] Whether a lower tax burden on income from capital translates in a higher demand for investment goods is an empirical question which has been extensively investigated in the economic literature, and it is out of the scope of this paper. See, for example, Backus, Henriksen and Storesletten (2008); Burnham and Ozanne (2006); De Mooij and Ederveen (2003); Devereux and Griffith (1998a); Devereux, Griffith and Klemm (2002); Devereux, Lockwood and Redoano (2008); and Slemrod (1990).

[2] See, for example, Congressional Budget Office (2005, 2006); European Commission (1992, 2001); Institute for Fiscal Studies (2009); and OECD (1991, 2007).

The empirical evidence suggests that lower corporate tax rates and/or temporary increase of tax depreciation allowances have been a recurrent feature of corporate tax policy in the United States and in the United Kingdom during economic downturns over the last 30 years. However, as tax rates have continuously declined over this period of time, TBIs have become the more predominant form of tax incentive.

To evaluate their impact on the ETR, we compare and contrast the relative effects of TRIs and TBIs within two investment frameworks. The first is consistent with the standard neoclassical theory, and assumes that shareholders wealth increases following either a TRI or a TBI, as both types of incentives increase the present value of dividend income. In particular, the standard economic theory advocates that TBIs, such as higher tax depreciation allowances for capital expenditure, increase the rate of investment because they defer tax payments to the future, in turn raising the present value of dividend income. This theory, however, neglects that accounting standards in OECD countries impose financial constraints on dividend policy preventing firms from distributing to shareholders any cash flows arising from deferred taxation. This is because TBIs are normally temporary tax incentives designed to provide firms with extra cash flow to undertake new investment, rather than distribute higher dividend income. As a result, a second investment model is designed to fully incorporate the effect of dividend policy constraints imposed on firms benefitting from a TBI. We show that within this second model, the benefit from a TBI is significantly lower than that predicted by the standard theory, hence TRIs are more likely to reduce the ETR than TBIs. In turn, this implies that as tax rates continue to decline in both the United States and the United Kingdom, there will be less and less scope to exploit the most effective tax tool (the tax cut) to stimulate business investment during recessions.[3]

Constraints on dividend policy linked with TBIs, as defined by the Generally Accepted Accounting Principles in the United States and the International Financial Reporting Standards in the United Kingdom, require firms to set full provision for any deferred tax asset or liability arising from temporary differences between the accounting value of assets and liabilities and their value for tax purposes. The importance of incorporating accounting constraints in investment models for tax policy analysis has already been pointed out by a relevant branch of the economic literature.[4] Although the actual constraint depends on the gap between the accounting and the tax evaluation of assets and liabilities, most of this literature assumes that the accounting value of assets and liabilities fully reflects their economic value. This corresponds to assume that accounting depreciation equals economic depreciation in our analysis, which is a plausible assumption not least because over the past 10-15 years accounting standards

[3] Indeed, even if the corporate tax rate reached zero, a government can still engineer a tax rate cut by granting a tax credit, which in this case would result in a direct income transfer from the government to the corporate sector. It is doubtful, however, that such policy will be politically and financially feasible.

[4] See, for example, Boadway and Bruce (1979), Kanniainen and Södersten (1994 and 1995), King (1974), Sørensen (1995), and Mills (2006).

followed by United States and United Kingdom companies have increased their flexibility in order to align accounting depreciation to economic depreciation.[5] Nevertheless, we departure from the conventional literature and generalise our constrained version of the neoclassical investment model allowing the size of provision for deferred taxes to depend on the gap between accounting and tax depreciation, as prescribed in the accounting standards, the former being different from economic depreciation. Our analysis also differs in four instances from Polito (2009), who incorporates accounting constraints on dividend policy into the Jorgenson (1963) investment model and uses this new framework to compute ETRs in the special case of domestic investment financed by retained earnings. First, this paper adopts a discrete time approach, while Polito (2009) employs the alternative, though mathematically equivalent, continuous time version of Jorgenson (1963) model. Second, since the focus here is on the impact of TRIs and TBIs on the ETR, this paper shows analytically how changes in tax rates and tax depreciation impact differently on the ETR in the unconstrained and constrained version of the model, while this type of analysis is not carried out in Polito (2009) which focuses on the effect of changes in investment profitability under the two models. Third, this paper shows that the negative effect of dividend policy constraints holds for every form of investment finance (retained earnings, new equity and debt), while Polito (2009) considers retained earnings alone. Fourth, the empirical application of this paper focuses on the time series analysis of ETRs in the United States and in the United Kingdom for the whole period 1979-2010, while Polito (2009) considers 5 EU countries in 2008 alone.

Our empirical findings show that the unconstrained model significantly overstates the benefit of temporary increase in tax allowances for capital spending, especially when investment is financed by retained earnings and yields a low rate of return: in other words, TBIs are far less effective than TRIs. Tax rate cuts are effective in reducing the ETR, unless investment is financed by debt and yields a low rate of return. These results are shown to hold when considering taxation at corporate level alone, taxation at personal level, for investment in both plant and machinery and industrial buildings, and regardless of the value of accounting depreciation relative to the rate of economic depreciation.

The paper is organised as follow. In Section 2 the approach developed by Devereux and Griffith to calculate ETR is briefly described. We consider the ETR for a domestic investment financed by either retained earnings or new equity or debt and use the framework to evaluate how TRIs and TBIs impact on the ETR. Section 3 clarifies how accounting constraints limit dividend policy when firms can defer tax payments following a TBI, and illustrates the implications of these constraints for the cost of capital. Section 4 introduces dividend policy constraints into the neoclassical framework and revisits the effects of TRIs and TBIs within this constrained model. Section 5 briefly presents data on the taxation of income from capital the United States and in the United Kingdom

[5] Indeed, the IAS 16 (International GAAP 2010) does not prescribe any specific method and/or rate of depreciation for accounting purposes, as it requires the depreciation charge to reflect the pattern of consumption of the benefits the assets brings over its useful life, which is essentially consistent with economic depreciation.

from 1979 to 2010. Section 6 summarises the results obtained by using these data to compute ETRs in both countries under the two models over the last thirty years. Section 7 states our conclusions. Appendix A at the end of the paper describes in detail all tax data used in this paper.

2 The ETR on income from capital

The Devereux and Griffith model (Devereux and Griffith, 1998a and 1998b; European Commission, 2001; Devereux, 2004) considers a competitive firm seeking to maximise its shareholders wealth, while facing a perfectly elastic supply of capital and a frictionless capital market, where it can borrow and lend at the constant nominal interest rate i. The nominal interest rate is related to the real rate r through the Fisher equation $(1+i) = (1+r)(1+\pi)$, where π is the constant inflation rate from t to $t+1$. Investment choices are riskless and taken in the absence of bankruptcy costs.

The model considers a simple one period investment: it is supposed that in a period t the firm increases its capital stock by making an investment of one unit, while decreasing its capital stock by the same amount in the following period t+1.

The increase in the shareholders wealth induced by the investment is equal to the net present value of the economic rent generated:

$$\Delta W_t = \sum_{s=0}^{\infty} \frac{\gamma \Delta D_{t+s} - \Delta N_{t+s}}{(1+\rho)^s}, \tag{1}$$

where ΔD and ΔN denote the change in dividend income and new equity issues, from period t onward; γ is the after-tax income received by shareholders for any unit increase in dividend income; ρ is the shareholders' discount rate. In particular, $\gamma = \left(1-m^d\right)/(1-z)(1-c)$, where m^d, z and c measure the personal tax rates on dividend income, accrued capital gains and the imputation rate, respectively;[6] and $\rho = i\left(1-\tau^i\right)/(1-z)$, with τ^i denoting the personal tax rate on interest income.

Dividend income is computed in any period t from the identity between sources and uses of funds

$$\Delta B_t + N_t + Q_t(K_{t-1}) - iB_{t-1} = D_t + I_t + T_t, \tag{2}$$

where ΔB_t denotes the change in the stock of debt in period t; $Q_t(K_{t-1})$ is output in period t depending on the stock of capital in the previous period, K_{t-1}, having normalised prices of output and capital goods to unity; iB_{t-1} measures interest payments on the outstanding stock of debt; I_t is the investment undertaken in period t, and T_t measures the period t corporate tax liability.[7] The

[6] The definition of γ implies that, $\gamma \gtreqless 1$, when the net tax on dividend income is lower, equal or higher than the capital gain tax rate.

[7] $Q_t(.)$ is a standard neoclassical investment function, which is continuos and twice differentiable, with positive first derivative and negative second derivative.

capital stock evolves according to the capital accumulation equation

$$K_t = (1-\delta) K_{t-1} + I_t, \tag{3}$$

where δ is the rate of economic depreciation of the capital stock.

The tax liability is formulated as

$$T_t^c = \tau \left[Q_t (K_{t-1}) - iB_{t-1} - \phi \left(I_t + K_{t-1}^T \right) \right], \tag{4}$$

where τ is the statutory tax rate, ϕ is the tax allowance on capital spending, and K_{t-1}^T is the tax-written-down value of the capital stock at the end of period t, which evolves according to

$$K_t^T = (1-\phi) K_{t-1}^T + I_t. \tag{5}$$

Assuming that the tax code grants tax depreciation allowances on a declining balance basis, the present value of the tax saving generated by the allowances per unit of investment in physical capital, A_ϕ, is measured as

$$A_\phi = \tau\phi + \tau \sum_{s=1}^{\infty} \left(\frac{1-\phi}{1+\rho} \right)^s = \tau\phi \frac{(1+\rho)}{\rho+\phi}, \tag{6}$$

where $\tau\phi$ denotes the tax saving generated by the initial period (t) capital allowance and $\tau \sum_{s=1}^{\infty} \left(\frac{1-\phi}{1+\rho} \right)^s$ measures the present discounted value of the tax saving from any capital allowance received from $t = 1$ onward. Equation (6) immediately shows that an increase in either the corporate tax rate or the capital allowance rate raises the present discounted value of the tax saving from capital allowances since

$$\frac{\partial A_\phi}{\partial \tau} = \phi \frac{(1+\rho)}{\rho+\phi} > 0,$$
$$\frac{\partial A_\phi}{\partial \phi} = \tau \frac{\rho(1+\rho)}{(\rho+\phi)^2} > 0.$$

Following Jorgenson (1963) and Hall and Jorgenson (1967), the traditional method of measuring the impact of capital income taxation on investment choices is based on the maximisation of the net return from capital investment in equation (1) with respect to K_t, subject to the constraints in equations (2) to (5). Assuming that the investment is financed by retained earnings, the first order condition for $t = 0, 1, 2, ...$ is:

$$-\gamma (1-A_\phi) + \frac{\gamma}{1+\rho} \left[(1-\tau)(p+\delta)(1+\pi) + (1-\delta)(1-A_\phi)(1+\pi) \right] \geq 0. \tag{7}$$

The first term on the left hand side of (7) is the net present value of the cost of the investment for the shareholders and the second one is the after tax present value of the return from the investment, which includes after tax gross nominal return $(1-\tau)(p+\delta)(1+\pi)$ and the residual nominal value of capital $(1-\delta)(1-A_\phi)(1+\pi)$, with p denoting the net financial return generated by investment in physical capital [8].

For marginal investment projects equation (7) holds with equality and it can be solved for the user cost of capital $p=\tilde{p}$. It holds with inequality whenever investment projects yield an expected rate of return in excess of the marginal rate.[9] In this second case, physical capital generates an economic rent R, namely a rate of return which exceeds the marginal rate. Hence, the investment condition in equation (7) can be formulated as

$$R_{U,RE}=\frac{\gamma}{1+\rho}\left\{(1-\tau)(p+\delta)(1+\pi)-\left[\rho+\delta(1+\pi)-\pi\right](1-A_\phi)\right\}\geq 0, \tag{8}$$

where $R_{U,RE}$ denotes the after tax economic rent, the subscript U indicating the absence of any constraint on dividend policy ("unconstrained" dividend policy) and RE specifying that the investment is financed by retained earnings.

Note that in the absence of taxes, the above reduces to

$$R^*=\frac{p-r}{1+r}\geq 0, \tag{9}$$

which holds with equality for marginal investment projects.

The applied version of the model extends the relation in equation (8) to the case of investment financed by either new equity or debt. When investment is financed by new equity issues, in the current period the firms need to raise new equity for the net investment cost $1-\tau\phi$. Consequently, compared to the case of retained earnings, in the current period shareholders contribute by $1-\tau\phi$ but their dividend payout increases by $\gamma(1-\tau\phi)$. In the subsequent period the amount $(1-\gamma)(1-\tau\phi)$ is distributed to shareholders as a repurchase of equity. Combining these effects, the economic rent for investment financed by new equity, $R_{U,NE}$, can be formulated as

$$R_{U,NE}=R_{U,RE}-\frac{\rho(1-\gamma)(1-\tau\phi)}{1+\rho}. \tag{10}$$

Hence, under the standard formulation of the model, the impact of new equity finance on the economic rent depends upon the taxation of dividend income relative to capital gains, as summarised by the parameter γ. When the tax system does not discriminate between dividend income and capital gains, $\gamma=1$, then the value of the after tax economic rent under new equity finance is the same as under retained earnings. When dividend income is taxed more than capital gains, $\gamma<1$, then the economic rent under new equity finance is lower than under retained earnings, since it is more efficient to finance investment

[8] In other words p represents the return measured in terms of EBIT (earnings before income and taxes): it is given by $p=\frac{\partial Q_{t+1}(K_t)}{\partial K_t}-\delta$

[9] See Devereux and Griffith (1998b, 2003), for a justification of this condition in partial equilibrium investment models.

using the source of income subject to the smaller tax burden (retained earnings). Viceversa, when dividend income is taxed less than capital gains, $\gamma > 1$, then the economic rent under new equity finance is higher than under retained earnings, because investment is financed with the less expensive form of finance.

Under debt finance, shareholders borrow the amount $1 - \tau\phi$ to finance investment. Hence, compared to the case of retained earnings, in the current period shareholders receive an amount $\gamma(1 - \tau\phi)$, which is repaid with interest in the following period. After taking into account that interest payments are deductible for corporate tax purposes, the net cost of repaying debt reduces the size of the dividend payment in period $t + 1$, relative to the retained earnings case, by the amount $\gamma(1 - \tau\phi)[1 + i(1 - \tau)]$. Combining these effects, the economic rent for investment financed by debt, $R_{U,B}$, is described as

$$R_{U,B} = R_{U,RE} + \frac{\gamma(1 - \tau\phi)[\rho - i(1 - \tau)]}{1 + \rho}, \qquad (11)$$

where the second term on the right-hand side of equation (11) measures the benefit from debt financing.

Effectively, under debt finance the firm postpones the payment of the cost of capital by one period. If the interest rate is not taxed at personal level, $\rho = i$, and the cost of borrowing is undeductible from the corporate tax base, then $R_{U,B} = R_{U,RE}$ and there is no benefit from debt finance. If the interest rate is not taxed at personal level, $\rho = i$, and the cost of borrowing is deductible from the corporate tax base, then

$$R_{U,B} = R_{U,RE} + \frac{\gamma(1 - \tau\phi)i\tau}{1 + i},$$

which shows that debt financing increases the economic rent. If the cost of borrowing is undeductible from the corporate tax base and interest income is taxed at personal level, then

$$R_{U,B} = R_{U,RE} + \frac{\gamma(1 - \tau\phi)(\rho - i)}{1 + \rho},$$

which shows that the benefit of debt financing depends on the value of ρ relative to i, as $R_{U,B} \gtreqless R_{U,RE}$ for $\rho \gtreqless i$.

Equations (8) - (11) provide formulations of the economic rent under alternative forms of finance which are fairly standard in the corporate tax literature, and can be used to measure the ETR on income from capital, defined as the difference between the economic rent before and after taxes, measured as a proportion of the discounted value of p:

$$ETR_{U,j} = \frac{R^* - R_{U,j}}{p/(1 + r)}, \qquad (12)$$

where the subscript $j = RE, NE, B$ distinguishes between three forms of investment finance. Equation (12) shows that any tax measure that increases (reduces) the after economic rent $R_{U,j}$ has the effect of reducing (increasing) the ETR on income from capital.

We can now employ these measures to evaluate how TRIs and TBIs impact on the ETR according to the traditional neoclassical investment theory.

2.1 Retained earnings

We first study how the $ETR_{U,RE}$ varies with investment profitability. This is important because it reveals how the effective tax burden on income from capital is likely to change over the business cycle. After incorporating the economic rent in equation (8) into the formula for the ETR in (12) and rearranging, the ETR is formulated as

$$ETR_{U,RE} = 1 - \frac{r}{p} - \frac{(1+r)\,\gamma}{(1+\rho)\,p}\left[(1-\tau)\,(p_{U,RE}+\delta)\,(1+\pi) - [\rho + \delta\,(1+\pi) - \pi]\,(1-A_\phi)\right].$$

Assuming that interest income and capital gains are not taxed at personal level, $i = \rho$, the above simplifies to

$$ETR_{U,RE} = 1 - \gamma\,(1-\tau) - \frac{r\,(1-\gamma) - \gamma\,[\tau\delta - (r+\delta)\,A_\phi]}{p}.$$

If defining the present value of the tax saving which would be generated by economic depreciation as

$$A_\delta = \tau \sum_{s=1}^{\infty} \left(\frac{1-\delta}{1+r}\right)^s = \frac{\tau\delta}{r+\delta} \tag{13}$$

the above becomes

$$ETR_{U,RE} = 1 - \gamma\,(1-\tau) - \frac{r\,(1-\gamma) - \gamma\,(r+\delta)\,(A_\delta - A_\phi)}{p}. \tag{14}$$

Equation (14) shows that the $ETR_{U,RE}$ includes two components: the first term, $1 - \gamma\,(1-\tau)$, is the permanent component of the ETR, entirely dependent on the government design of the capital income taxation system at both corporate and personal level. The second term is the temporary component of the effective tax burden, which is related to investment profitability. Note that using the definitions in equations (6) and (13) and in the absence of taxation at shareholders level, $\gamma = 1$, the ETR in equation (14) becomes

$$ETR_{U,RE} = \tau + \frac{\tau\,[\delta - (1+r)\,\phi]}{p}$$

which shows that the $ETR \gtreqless \tau$ if $\delta \gtreqless (1+r)\,\phi$. We now consider two special cases. First we assume that the tax code does not grant the first year tax depreciation allowance. Hence, $A_\phi = \frac{\tau\phi}{r+\phi}$ and the ETR becomes

$$ETR_{U,RE} = \tau + \frac{\tau\,(\delta - \phi)}{p}$$

which shows that the $ETR \gtreqless \tau$ if $\delta \gtreqless \phi$. Therefore, if the tax system allows just the deduction of economic depreciation, it follows that

$$ETR = \tau.$$

The sensitiveness of the $ETR_{U,RE}$ to investment profitability is measured from (14) as

$$\frac{\partial ETR_{U,RE}}{\partial p} = \frac{r\left(1-\gamma\right) - \gamma\left(r+\delta\right)\left(A_{\delta} - A_{\phi}\right)}{p^2}.$$

The above shows that the sensitiveness of the ETR to investment profitability depends on the taxation of dividend income relative to capital gains and the difference between tax and economic depreciation. In general, the above expression is always negative whenever dividend income is taxed more than capital gains and tax depreciation exceeds economic depreciation. In particular, we note the following results:

1. $\frac{\partial ETR_{U,RE}}{\partial p} = 0$, when dividend income is taxed as capital gains ($\gamma = 1$) and tax depreciation equals economic depreciation ($A_{\delta} = A_{\phi}$);
2. $\frac{\partial ETR_{U,RE}}{\partial p} = \frac{r(1-\gamma)}{p^2}$, when dividend income is taxed differently from capital gains ($\gamma \neq 1$), but tax depreciation equals economic depreciation($A_{\delta} = A_{\phi}$);
3. $\frac{\partial ETR_{U,RE}}{\partial p} = \frac{-(r+\delta)(A_{\phi}-A_{\delta})}{p^2}$, when dividend income is taxed as capital gains ($\gamma = 1$) but tax depreciation exceeds economic depreciation ($A_{\delta} < A_{\phi}$).

Investment profitability is pro-cyclical, hence when there is no discrimination between dividend income and capital gains in the tax system, the effective tax burden on income from capital is anti-cyclical as long as tax depreciation allowances exceed economic depreciation. In this case the ETR increases during phases of expansions, while falling during contractions.

The effect of a TBI on the ETR for investment financed by retained earnings can be measured by evaluating the impact of an increase in the tax allowance on capital spending:

$$\frac{\partial ETR_{U,RE}}{\partial \phi} = -\frac{\gamma\left(r+\delta\right)}{p}\frac{\partial A_{\phi}}{\partial \phi}, \tag{15}$$

which shows that an increase in the tax depreciation allowance rate reduces the ETR. This result has a straightforward economic interpretation: a higher tax allowance on capital spending shrinks the tax base in the current period relative to the future, in turn increasing the present value of dividend income distributable to shareholders. The increase in the economic rent resulting form the higher capital allowance results then in the reduction of the ETR. Conversely, the ETR increases following a reduction in the capital allowance.

We can also study how the ETR responds to a TRI. After differentiating equation (14) with respect to the corporate income tax rate we obtain:

$$\frac{\partial ETR_{U,RE}}{\partial \tau} = \gamma \left[1 + \frac{\delta}{p} - \frac{(1+r)(r+\delta)}{p\,(r+\phi)} \phi \right] \tag{16}$$

Hence, in principle, an increase of the corporate tax rate has an ambiguous effect on the economic rent and the ETR. The first two terms in the square brackets measure the impact of the higher tax rate on the gross return on investment, which clearly increases the ETR. The last term measures the impact of a change in the corporate tax rate on the ETR through the tax base. This is negatively related to the ETR since the higher corporate tax rate increases the present value of the tax saving from capital allowances, in turn reducing the tax base. Notice that when dividend income is taxed as capital gains, $\gamma = 1$, if $\delta = \phi$, the right hand side of the above reduces to 1, which shows that a TRI reduces the ETR one for one when tax depreciation equals economic depreciation. More generally, if $\phi \neq \delta$, then $\frac{\partial ETR_{U,RE}}{\partial \tau} \gtreqless 0$ when $(p+\delta)\,(r+\phi) \gtreqless \phi\,(1+r)(r+\delta)$.

2.2 New equity

Combining the definitions in equations (12) and (10), the ETR is formulated as

$$ETR_{U,NE} = ETR_{U,RE} + \rho \frac{(1-\gamma)\,(1-\tau\phi)\,(1+r)}{(1+\rho)\,p}. \tag{17}$$

The above shows that the ETR under new equity finance includes two terms. The first measures the effective tax burden on the present value of dividend income generated by the investment, as in the case of retained earnings. The second term measures the impact on the effective tax burden of new equity finance relative to retained earnings, which in turn depends on the taxation of dividend income relative to capital gains, as measured by γ. When dividend income is taxed as capital gains, $\gamma = 1$, then the $ETR_{U,NE}$ equals that under retained earnings. If dividend income is taxed more (less) than capital gains, $\gamma < (>) 1$, then new equity finance is less (more) efficient than retained earnings finance and the $ETR_{U,NE}$ is higher (lower) than $ETR_{U,RE}$.

From equation (17) it follows that the sensitiveness of the ETR to changes in investment profitability is measured by

$$\frac{\partial ETR_{U,NE}}{\partial p} = \frac{\partial ETR_{U,RE}}{\partial p} - \rho \frac{(1-\gamma)\,(1-\tau\phi)\,(1+r)}{(1+\rho)\,p^2},$$

which shows that the cost ($\gamma < 1$) or the benefit ($\gamma > 1$) of new equity finance relative to retained earnings fades away as investment profitability raises.

Equation (17) also shows that the impact of new equity finance relative to retained earnings depends on tax saving generated by the first year allowance rate, $\tau\phi$. The first year tax depreciation allowance has the effect of reducing the cost of capital in the first period, in turn implying that the firm needs to rely less on any other form of finance.

The effect of a TBI under new equity finance is measured by differentiating with respect to ϕ the ETR in equation (17), which yields

$$\frac{\partial ETR_{U,NE}}{\partial \phi} = \frac{\partial ETR_{U,RE}}{\partial \phi} - \rho \frac{\tau (1-\gamma)(1+r)}{(1+\rho) p}. \tag{18}$$

The two terms on the right-hand side of equation (18) show that a TBI has two effects on the ETR under new equity finance. First, the increase of the tax depreciation allowance reduces the $ETR_{U,RE}$ since it raises the present value of dividend income distributable to shareholders. The second effect refers to the impact on the financial benefit from new equity finance relative to retained earnings. Consider the case of new new equity finance being the most tax efficient form of finance, $\gamma > 1$. In this case, the ETR on investment financed by new equity issue increases relative to that under retained earnings taxation because by reducing the proportion of investment financed with the most efficient form of finance the higher capital allowance reduces the benefit of new equity finance relative to retained earnings. The opposite occurs when $\gamma < 1$.

Note that since the tax saving from tax depreciation allowance is proportional to the statutory corporate tax rate, it follows immediately that increases of the corporate tax rate will have an effect on the new equity component of the ETR similar to that of an increase of the capital allowance. In fact, the impact of a change in the corporate tax rate on the economic rent generated is given by

$$\frac{\partial ETR_{U,NE}}{\partial \tau} = \frac{\partial ETR_{U,RE}}{\partial \tau} - \frac{\rho (1-\gamma)(1+r)\phi}{(1+\rho) p}.$$

Consequently, a TRI increases (reduces) the financial benefit of new equity finance relative to retained earnings when $\gamma < 1$ ($\gamma > 1$).

2.3 Debt

Combining (12) with (11), the effective tax burden on debt financed investment is formulated as

$$ETR_{U,B} = ETR_{U,RE} - \gamma \frac{(1-\tau\phi)[\rho - i(1-\tau)](1+r)}{(1+\rho) p}. \tag{19}$$

Hence, the overall impact of debt financing on the effective tax burden, as measured by the second term on the right hand side depends on $\rho - i(1-\tau)$. This term is positive whenever the personal tax rate on interest income is lower than the corporate income tax rate ($\tau^i < \tau$), in turn implying that $ETR_{U,B} < ETR_{U,RE}$, which is a condition generally holding for most of OECD countries.

Several special cases may be noted here. If the interest rate is not taxed at personal level, $\rho = i$, and the cost of borrowing is undeductible from the corporate tax base, then $ETR_{U,B} = ETR_{U,RE}$ and there is no benefit from debt finance. If the interest rate is not taxed at personal level, $\rho = i$, and the cost of borrowing is deductible from the corporate tax base, then

$$ETR_{U,B} = ETR_{U,RE} - \gamma \frac{i\tau (1-\tau\phi)(1+r)}{(1+i) p},$$

which shows that debt financing increases reduces the ETR. If the cost of borrowing is undeductible from the corporate tax base and interest income is taxed at personal level, then

$$ETR_{U,B} = ETR_{U,RE} - \gamma \frac{(1-\tau\phi)\,[\rho - i]\,(1+r)}{(1+\rho)\,p}.$$

and the benefit of debt financing depends on the value of ρ relative to i, as $ETR_{U,B} \lesseqgtr ETR_{U,RE}$ when $\rho \gtreqless i$.

Equation (19) shows that the benefit of debt finance on the ETR increases as investment profitability raises since

$$\frac{\partial ETR_{U,B}}{\partial p} = \frac{\partial ETR_{U,RE}}{\partial p} + \gamma \frac{(1-\tau\phi)\,[\rho - i\,(1-\tau)]\,(1+r)}{(1+\rho)\,p^2}.$$

The impact of a TBI on the $ETR_{U,B}$ is measured by

$$\frac{\partial ETR_{U,B}}{\partial \phi} = \frac{\partial ETR_{U,RE}}{\partial \phi} + \gamma \frac{\tau\,[\rho - i\,(1-\tau)]\,(1+r)}{(1+\rho)\,p}, \tag{20}$$

which shows that an increase in the tax depreciation allowance has two opposite effects on the ETR. On the one hand, it reduces the ETR as it increases the present value of dividend income distributable to shareholders. On the other hand, it reduces the benefit of debt financing relative to retained earnings as the higher capital allowance decreases the amount of interest income deductible form the tax base.

As previously pointed out, several special cases can occur depending on the taxation of interest income at personal and corporate level. If interest income is not deductible from the corporate tax base and is not taxed at personal level, then the above becomes

$$\frac{\partial ETR_{U,B}}{\partial \phi} = \frac{\partial ETR_{U,RE}}{\partial \phi}.$$

If the interest rate is not taxed at personal level, $\rho = i$ but the cost of borrowing is deductible from the corporate tax base, then

$$\frac{\partial ETR_{U,B}}{\partial \phi} = \frac{\partial ETR_{U,RE}}{\partial \phi} + \gamma \frac{i\tau^2\,(1+r)}{(1+\rho)\,p}.$$

This result has the following economic interpretation. A TBI has the effect of reducing the proportion of investment financed by borrowing, in turn reducing the benefit of debt financing relative to retained earnings.

If the cost of borrowing is undeductible from the corporate tax base and interest income is taxed at personal level, then

$$\frac{\partial ETR_{U,B}}{\partial \phi} = \frac{\partial ETR_{U,RE}}{\partial \phi} + \gamma \frac{\tau\,[\rho - i]\,(1+r)}{(1+\rho)\,p}$$

which shows that an increase in the tax depreciation allowance reduces the relative benefit of debt financing.

Finally, the impact of an increase in the corporate tax rate is measured by

$$\frac{\partial ETR_{U,B}}{\partial \tau} = \frac{\partial ETR_{U,RE}}{\partial \tau} + \gamma \left\{ \phi \left[\rho - i \left(1 - \tau \right) \right] - \left(1 - \tau \phi \right) i \right\} \frac{(1+r)}{(1+\rho)\, p}.$$

The term in the curly brackets on the right hand side shows that an increase in the corporate tax rate has two effects on the debt component of the ETR. The first is captured by the term $\phi\left[\rho - i\left(1-\tau\right)\right]$. As pointed out earlier, since interest income is generally taxed less at personal level than at corporate level, $\rho > i\left(1-\tau\right)$. This implies that, as for the case of a TBI, an increase in the corporate tax rate has the effect of reducing the proportion of investment cost financed by retained earnings, hence reducing the benefit of debt financing relative to retained earnings, in turn increasing the ETR. The second term, captured by $\left(1-\tau\phi\right) i$, measures the benefit arising from the higher proportion of interest income deductible from the corporate tax base, which clearly reduces the ETR as the corporate tax rate raises. Consequently, a TRI has two effects on the debt component of the ETR: on the one hand, it reduces the ETR by increasing the proportion of the cost of capital financed by borrowing; on the other hand it increases the ETR by reducing the value of interest payments deductible from the tax base.

3 Deferred taxation and the cost of capital

As anticipated in the introduction firms investing in the United States and in the United Kingdom have to comply with accounting rules which prevent the distribution to shareholders of any spare cash flow generated by deferred taxation. In particular, in any period t a firm has to set a provision equal to the tax rate multiplied by the difference between the capital allowance deductible for tax purposes and the corresponding value deductible for accounting purposes. This implies that dividend income in any period t cannot exceed the after-tax profit reduced by the provision. The literature on accounting constraints and corporate tax policy assumes accounting depreciation to be equal to economic depreciation, which would imply a period t constraint on dividend policy written as $\tau\left(\phi K_t^T - \delta K_t\right)$. We departure from this assumption and consider the more general case in which accounting depreciation may differ from economic depreciation. If we denote by υ the accounting rate of depreciation and by K_t^{υ} the outstanding value of the capital stock for accounting purposes, the deferred tax set in a generic period t, T_t^d,can be written as

$$T_t^d = \tau\left(\phi K_t^T - \upsilon K_t^{\upsilon}\right), \tag{21}$$

As stated by Kanniainen and Södersten (1995), the positive temporary difference between the capital allowance and accounting depreciation give rise to a deferred tax liability which must be retained by the firm rather than be distributed to shareholders. In principle, the constrained liquidity should be used to carry out new investment. However, this would be in conflict with the model assumption of a one-unit increase in capital in period t and an equal decrease starting from $t + 1$. As a result, following Polito (2009), financial resources constrained in provisions for deferred taxes represent an excess of liquidity that firms can only invest in the capital markets. In turn, this implies that deferred taxation generates to shareholders a cash-flow equal to the after-tax rate of return on the resources constrained in provisions for deferred taxes.

There are several equivalent ways of incorporating financial constraints on dividend policy into the neoclassical investment model. King (1974) and Kanniainen and Södersten (1995) treat the dividend policy constraint just as an extra constraint in the maximisation problem of the firm. Polito (2009) shows that the financial constraint can also be incorporated into the neoclassical model by opportunely modifying the identity between sources and uses of funds. This paper instead introduces financial constraints into the model by specifying the total tax liability of the firm in any period t, T_t, as the sum of current and deferred taxes. In particular, the corporate tax function can be formulated as

$$T_t = T_t^c + T_t^d, \tag{22}$$

where current taxes T_t^c are defined as in equation (4), and T_t^d is defined in (21). This shows that a new source tax liability arises to shareholders in the form of undistributable tax savings. The formulation of the tax function in equations (22) and (21) is essentially consistent with how firms report their tax liability in their accounts, hence providing a very transparent way of disclosing the impact of the constraint on dividend policy.[10]

We can now appraise how accounting constraints on dividend policy affect the cost of capital. In the first period, under the standard theory, the capital allowance reduces the cost of capital by $\phi\tau$. Since accounting depreciation can be deducted from period $t = 1$ onward, it follows that the entire value of the tax saving generated by the first year allowance cannot be distributed to shareholder as it represents a deferred tax which has to be retained by the firm into a provision for deferred taxes. This implies that the cost of capital increases in t by $\phi\tau$, which entirely neutralises the benefit of the initial capital allowance.

In order to allow the possibility of interest income being taxed at a different rate with respect to profits, we denote with τ^c the rate on interests at corporate level. Thus resources accumulated in provisions for deferred taxes and invested by the firm in the financial market earn the after tax rate of return $i(1-\tau^c)$. This financial return can be distributed to shareholders in turn contributing to the reduction of the cost of capital by $i(1-\tau^c)\phi\tau$. Hence the net cost of capital in the presence of accounting constraints on dividend policy is given by $1 - i(1-\tau^c)\phi\tau$. This shows that omission of the constraint, as in the standard analysis, has the effect of understating the net cost of investment faced by shareholders. Equivalently, this shows that the benefit of a TBI consisting in a higher first year capital allowance is considerably overstated by the standard

[10] For a detailed description of the rules for recording timing differences in a company's financial statement, see Alexander and Archer (2009).

analysis. Conversely, the negative effect of a TRI through the first year capital allowance is much smaller than that predicted by the standard theory.

The firm also benefits from the deduction of tax depreciation allowances for $t \geq 1$. If we denote by $A_{\upsilon} = \tau \sum_{s=1}^{\infty} \left(\frac{1-\upsilon}{1+\rho}\right)^{s} = \frac{\tau\upsilon}{\rho+\upsilon}$ the present discounted value of the tax saving due to accounting depreciation, then the overall present discounted value of provisions for deferred taxes, Δ, is measured as

$$\begin{aligned} \Delta &= A_{\phi} - A_{\upsilon} \\ &= \tau\phi + \frac{\tau\rho\,(\phi-\upsilon)}{(\rho+\phi)\,(\rho+\upsilon)}, \end{aligned} \tag{23}$$

which shows that with $\phi = \upsilon$ we still have $\Delta > 0$ because of the effect of the first year allowance.

As we have seen the present discounted value of the corresponding financial return distributable to shareholders generated by the investment in the financial market of these resources is given by

$$i\,(1-\tau^{c})\,\Delta, \tag{24}$$

Hence, equations (23) and (24) measure the impact of accounting constraint on the cost of capital: on the one hand, accounting constraints on dividend policy increase the cost of capital by preventing the distribution to shareholders of any tax saving generated by capital allowances for depreciation, as measured by Δ in equation (23). Since resources accumulated in provisions for deferred taxes are invested in the financial market, accounting constraints on dividend policy generate a return in present value equal to $i\,(1-\tau^{c})\,\Delta$.

4 The ETR under constrained dividend policy

4.1 Retained earnings

After incorporating the definitions in equations (23) and (24) into equation (8), the rent on investment financed by retained earnings is written as

$$\begin{aligned} R_{C,RE} &= -\gamma\left\{1 - A_{\phi} + \left[1 - i\,(1-\tau^{c})\right]\Delta\right\} + \frac{\gamma\,(1-\tau)\,(p+\delta)\,(1+\pi)}{1+\rho} + \\ &\quad + \frac{\gamma\,(1-\delta)\,(1+\pi)}{1+\rho}\left\{1 - A_{\phi} + \left[1 - i\,(1-\tau^{c})\right]\Delta\right\}, \end{aligned} \tag{25}$$

where the subscript C denotes that dividend policy is "constrained" by the accounting rules on deferred taxation. The above can be rearranged, using the definition in (8), as

$$R_{C,RE} = R_{U,RE} + \frac{\gamma\left[1 - i\,(1-\tau^{c})\right]\Delta}{1+\rho}\left[(1-\delta)\,(1+\pi) - (1+\rho)\right]$$

The second term on the right hand side shows the overall effect of the accounting constraint on the after tax economic rent under retained earnings finance.

Assuming that interest income and capital gains are taxed with the same rate at personal level, so that $\rho = i$, the above becomes

$$R_{C,RE} = R_{NC,RE} - \frac{\gamma\left[1 - i\left(1 - \tau^c\right)\right]\Delta}{(1+r)}\left(r + \delta\right),$$

which shows that the accounting constraint decreases the standard measure of the economic rent whenever $\Delta > 0$, i.e. tax depreciation exceeds accounting depreciation.

Using the definition in (13), the above can be written as

$$R_{C,RE} = R_{U,RE} - \frac{\gamma\left[1 - i\left(1 - \tau^c\right)\right]\delta\tau}{(1+r)}\frac{A_\phi - A_\upsilon}{A_\delta},$$

which shows how the interplay between tax, accounting and economic depreciation affects the impact of accounting constraint on dividend policy on the return from capital investment. We notice that in general the sign of the constraint is independent from economic depreciation as it is entirely determined by the difference between tax and accounting depreciation. It therefore follows that $R_{C,RE} \lesseqqgtr R_{U,RE}$ if $A_\phi \gtreqqless A_\upsilon$. This results holds unless accounting depreciation equals economic depreciation, as assumed in Kanniainen and Södersten (1994, 1995), in which case the above resolves to

$$R_{C,RE} = R_{U,RE} - \frac{\gamma\left[1 - i\left(1 - \tau^c\right)\right]\delta\tau}{(1+r)}\left(\frac{A_\phi}{A_\delta} - 1\right),$$

which implies that $R_{C,RE} \lesseqqgtr R_{U,RE}$ if $A_\phi \gtreqqless A_\delta$.

After combining the definition in (25) with (12), the ETR on investment financed by retained earnings in the presence of accounting constraints on dividend policy can be written as

$$\begin{aligned} ETR_{C,RE} &= \frac{R^* - R_{C,RE}}{p/(1+r)} \\ &= ETR_{U,RE} + \frac{\gamma\left[1 - i\left(1 - \tau^c\right)\right]\Delta\left(1+r\right)}{(1+\rho)\,p}\left[(1-\delta)(1+\pi) - (1+\rho)\right] \end{aligned} \tag{26}$$

which, in the special case of $\rho = i$, gives the solution

$$ETR_{C,RE} = ETR_{U,RE} + \frac{\gamma\left[1 - i\left(1 - \tau^c\right)\right]\Delta}{p}\left(r + \delta\right),$$

which shows that the ETR is higher then in the absence of constraint whenever tax depreciation exceeds accounting depreciation, $\Delta > 0$.

We can differentiate the above with respect to p to obtain

$$\frac{\partial ETR_{C,RE}}{\partial p} = \frac{\partial ETR_{U,RE}}{\partial p} - \frac{\gamma\left[1 - i\left(1 - \tau^c\right)\right]\Delta\left(r + \delta\right)}{p^2},$$

which shows that the sensitiveness of the ETR to investment profitability is overstated by the standard literature.

We can now study the impact of tax policy changes on the ETR in the presence of accounting constraints on dividend policy. A TBI results in

$$\frac{\partial ETR_{C,RE}}{\partial \phi} = \frac{\partial ETR_{U,RE}}{\partial \phi} + \frac{\gamma \left[1 - i\left(1-\tau^c\right)\right]\left(r+\delta\right)}{p}\frac{\partial A_\phi}{\partial \phi}.$$

Using the result in (15), the above can be written as

$$\frac{\partial ETR_{C,RE}}{\partial \phi} = i\left(1-\tau^c\right)\frac{\partial ETR_{U,RE}}{\partial \phi},$$

which shows that once accounting constraints are incorporated into the ETR the benefit of TBIs is significantly lower than under the unconstrained model.

To evaluate the effect of a TRI in the presence of accounting constraints, we differentiate (26) with respect to the corporate tax rate to obtain

$$\frac{\partial ETR_{C,RE}}{\partial \tau} = \frac{\partial ETR_{U,RE}}{\partial \tau} + \frac{\partial}{\partial \tau}\frac{\gamma \left[1 - i\left(1-\tau^i\right)\right]\Delta\left(r+\delta\right)}{p}.$$

Using the result in equation (16), the above becomes

$$\frac{\partial ETR_{C,RE}}{\partial \tau} = \gamma\left[1 + \frac{\delta}{p} - i\left(1-\tau^i\right)\frac{\left(r+\delta\right)}{p\left(r+\phi\right)}\phi\right] - \frac{\gamma \left[1 - i\left(1-\tau^c\right)\right]\left(r+\delta\right)\upsilon}{p\left(r+\upsilon\right)},$$

which can be compared with the corresponding expression from the unconstrained model in equation (16). Hence, the higher tax rate has the effect of reducing the tax base benefit observed in the unconstrained model by $1-i\left(1-\tau^c\right)$. In addition, the term $-\frac{\gamma(r+\delta)\upsilon}{p(r+\upsilon)}$ measures the reduction of the ETR as a result of the fall in the value of provisions for deferred taxes generated by the higher tax rate levied on accounting depreciation.

The term $\frac{\gamma i(1-\tau^c)(r+\delta)\upsilon}{p(r+\upsilon)}$ measures the increase in the ETR due to the lower value of financial resources to be invested in the financial market.

Notice that the above can be written as

$$\frac{\partial ETR_{C,RE}}{\partial \tau} = \frac{\partial ETR_{U,RE}}{\partial \tau} + \frac{\gamma \left[1 - i\left(1-\tau^c\right)\right]\left(r+\delta\right) r\left(\phi-\upsilon\right)}{p\left(r+\upsilon\right)\left(r+\phi\right)}$$

which shows that

$$\frac{\partial ETR_{C,RE}}{\partial \tau} \gtreqless \frac{\partial ETR_{U,RE}}{\partial \tau}$$

whenever $\phi \gtreqless \upsilon$. In other words, omission of the accounting constraint brings misleading policy assessment of the impact of TRIs on the effective tax burden on income from capital.

Two special cases are worth considering. First, if accounting depreciation equals economic depreciation, $\upsilon = \delta$ the above reduces to

$$\begin{aligned}\frac{\partial ETR_{C,RE}}{\partial \tau} &= \gamma\left[1 + \frac{\delta}{p} - i\left(1-\tau^c\right)\frac{\left(r+\delta\right)}{p\left(r+\phi\right)}\phi\right] - \frac{\gamma \left[1 - i\left(1-\tau^c\right)\right]\delta}{p} \\ &= \gamma\left[1 + i\left(1-\tau^c\right)\frac{\delta}{p} - i\left(1-\tau^c\right)\frac{\left(r+\delta\right)}{p\left(r+\phi\right)}\phi\right],\end{aligned}$$

which shows that the higher corporate tax rate has also a lower impact on the gross return of the investment.

Second, if $\upsilon = \delta$ and the after tax return from financial investment is negligible, i.e. $i(1-\tau^c) \simeq 0$, it follows that the above derivative equals γ: in other words, there is no tax base effect from a TRI.

4.2 New equity

When investment is financed by new equity, in the first period, the firm sets a provision for deferred taxes of $\tau\phi$. Recall that accounting depreciation can only be deducted from period $t = 1$ onward. Hence, in the first period the firm has to set a provision for deferred taxes equal to the tax rate multiplied by the entire first period capital allowance. This will earn a financial return of $i(1-\tau^c)\tau\phi$. Hence, the economic rent on investment financed by new equity becomes under accounting constraints

$$R_{C,NE} = R_{C,RE} - \frac{\rho(1-\gamma)\left[1 - i\left(1-\tau^i\right)\tau\phi\right]}{1+\rho}.$$

Using the definition in equation (25), the above can be written as

$$R_{C,NE} = R_{U,NE} - \frac{\gamma\left[1 - i(1-\tau^c)\right]\Delta}{1+\rho}\left[(1-\delta)(1+\pi) - (1+\rho)\right] - \frac{\rho(1-\gamma)\left[1 - i(1-\tau^c)\right]\tau\phi}{1+\rho},$$

which shows that accounting constraints on dividend policy add two effects on the return from investment financed by new equity in (10), measured by the last two terns on the right hand side of the above. The former term measures the reduction of the overall return due to the impact of the accounting constraint on the retained earning component of $R_{C,NE}$. The last term measures the effect of the accounting constraint on the new equity component of the return: in particular, this term is negative (positive) whenever dividend income is taxed more (less), $\gamma < 1$ ($\gamma > 1$), than capital gains. Consequently, the ETR for investment financed with new equity becomes

$$\begin{aligned} ETR_{C,NE} &= \frac{R^* - R_{C,NE}}{p/(1+r)} \\ &= ETR_{C,RE} + \rho\frac{(1-\gamma)\left[1 - i\left(1-\tau^i\right)\tau\phi\right](1+r)}{(1+\rho)p}, \end{aligned} \tag{27}$$

where the last term on the right hand side discloses the effect of the accounting constraint on the ETR when investment is financed by new equity relative to the case of retained earnings. It follows that

$$ETR_{C,NE} \gtreqless ETR_{U,NE}$$

if $\phi > \upsilon$, which shows that after considering accounting constraints on dividend policy the ETR is higher than predicted by the standard theory.

We can study how the ETR for investment financed by new equity changes following an increase in investment profitability by differentiating (27) with respect to p to obtain

$$\frac{\partial ETR_{C,NE}}{\partial p} = \frac{\partial ETR_{C,RE}}{\partial p} - \rho \frac{(1-\gamma)\left[1 - i\left(1-\tau^{i}\right)\tau\phi\right](1+r)}{(1+\rho)\, p^{2}}.$$

Notice that

$$\frac{\partial ETR_{C,NE}}{\partial p} \lesseqgtr \frac{\partial ETR_{U,RE}}{\partial p} \ \textbf{when} \phi \gtreqless \upsilon,$$

which shows that the sensitiveness of the ETR to a change in corporate profits is overstated by the omission of the accounting constraint.

To appraise the effect of a TBI, we differentiate equation (27) with respect to the rate of tax depreciation to obtain

$$\frac{\partial ETR_{C,NE}}{\partial \phi} = \frac{\partial ETR_{C,RE}}{\partial \phi} - \frac{\rho(1-\gamma)(1+r)\left[i\left(1-\tau^{c}\right)\tau\right]}{(1+\rho)\, p}.$$

Using the result in (18), the above becomes

$$\frac{\partial ETR_{C,NE}}{\partial \phi} = i\left(1-\tau^{c}\right)\frac{\partial ETR_{U,RE}}{\partial \phi},$$

which shows that TBIs have a significantly smaller impact on the ETR even in the case of new equity finance.

The effect of a TRI is studied by evaluating the derivative of (27) with respect to the tax rate, given by

$$\frac{\partial ETR_{C,NE}}{\partial \tau} = \frac{\partial ETR_{C,RE}}{\partial \tau} - \rho \frac{(1-\gamma)(1+r)\left[i\left(1-\tau^{c}\right)\phi\right]}{(1+\rho)\, p}.$$

The above can also be written as

$$\frac{\partial ETR_{C,NE}}{\partial \tau} = \frac{\partial ETR_{U,NE}}{\partial \tau} + \frac{\gamma\left[1 - i\left(1-\tau^{c}\right)\right](r+\delta)\, r\,(\phi - \upsilon)}{p\,(r+\upsilon)(r+\phi)} + \\ + \rho \frac{(1-\gamma)(1+r)\left[1 - i\left(1-\tau^{c}\right)\right]\phi}{(1+\rho)\, p}.$$

Note that if dividend income is not taxed less of capital gains, $\gamma \leq 1$, then $\frac{\partial ETR_{C,NE}}{\partial \tau} \gtreqless \frac{\partial ETR_{U,NE}}{\partial \tau}$ as long as $\phi \gtreqless \upsilon$, which imply that a TRI is more effective than under the unconstrained model. The effect is however ambiguous when dividend income is taxed less than capital gains, $\gamma > 1$.

4.3 Debt finance

Under debt finance the firm borrows in the first period all resources necessary to purchase the capital stock net of the first period capital allowance. However, the saving generated by tax allowance cannot be distributed to shareholders, as the firm sets a provision for deferred taxes of $\tau\phi$. The provision will therefore generate an after tax financial return of $i\left(1-\tau^{c}\right)\tau\phi$. This implies that the net amount borrowed under the accounting constraint to purchase one unit of capital is given by

$$1-i\left(1-\tau^{i}\right)\tau\phi,$$

and, consequently, the ETR on investment financed by debt can be formulated as

$$ETR_{C,B}=ETR_{C,RE}-\frac{\gamma\left[1-i\left(1-\tau^{c}\right)\tau\phi\right]\left[\rho-i\left(1-\tau\right)\right]\left(1+r\right)}{\left(1+\rho\right)p}, \tag{28}$$

which is generally lower than under retained earnings. We can now measure the sensitiveness of the $ETR_{C,B}$ to an increase in profitability by

$$\frac{\partial ETR_{C,B}}{\partial p}=\frac{\partial ETR_{C,RE}}{\partial p}+\frac{\gamma\left[1-i\left(1-\tau^{c}\right)\tau\phi\right]\left[\rho-i\left(1-\tau\right)\right]\left(1+r\right)}{\left(1+\rho\right)p^{2}}$$

or equivalently by

$$\begin{aligned}\frac{\partial ETR_{C,B}}{\partial p}=&\frac{\partial ETR_{U,B}}{\partial p}-\frac{\gamma\left[1-i\left(1-\tau^{c}\right)\right]\Delta\left(1+r\right)}{\left(1+\rho\right)p^{2}}\left[\left(1-\delta\right)\left(1+\pi\right)-\left(1+\rho\right)\right]\\&+\frac{\gamma\tau\phi\left[1-i\left(1-\tau^{c}\right)\right]\left[\rho-i\left(1-\tau\right)\right]\left(1+r\right)}{\left(1+\rho\right)p^{2}}.\end{aligned}$$

Hence an increase in investment profitability under accounting constraints on dividend policy adds two effects to the ETR measured for debt finance in the unconstrained model. First, the higher profitability reduces the net burden of the undistributed dividend income due to the presence of the accounting constraint, which in turn reduces the ETR. Second, the higher profitability reduces the benefit from debt finance under the accounting constraint, in turn increasing the ETR.

The impact of a TBI on the ETR in equation (28) is measured by

$$\frac{\partial ETR_{C,B}}{\partial\phi}=\frac{\partial ETR_{C,RE}}{\partial\phi}+\frac{\partial}{\partial\phi}\frac{\gamma\left[i\left(1-\tau^{c}\right)\tau\right]\left[\rho-i\left(1-\tau\right)\right]\left(1+r\right)}{\left(1+\rho\right)p}.$$

Using (20), the above becomes

$$\frac{\partial ETR_{C,B}}{\partial\phi}=i\left(1-\tau^{c}\right)\frac{\partial ETR_{U,B}}{\partial\phi}$$

which shows that - as for retained earnings and new equity finance - the omission of the accounting constraint significantly overstates the effect of TBIs on the ETR when investment is financed by debt. Finally, a change in the corporate income tax rate gives

$$\begin{aligned}\frac{\partial ETR_{C,B}}{\partial\tau}=&\frac{\partial ETR_{C,RE}}{\partial\tau}+\frac{\gamma\left(1+r\right)\left[i\left(1-\tau^{c}\right)\phi\right]\left[\rho-i\left(1-\tau\right)\right]}{\left(1+\rho\right)p}\\&-\frac{\gamma\left[1-i\left(1-\tau^{c}\right)\tau\phi\right]i\left(1+r\right)}{\left(1+\rho\right)p},\end{aligned}$$

which shows that the higher tax rate has two further effects on the ETR under debt finance relative to the retained earnings case. First, the higher tax rate increases the tax burden on the financial investment of resources accumulated in provisions for deferred taxes, in turn increasing the ETR. On the other hand, the higher tax rate increases the tax saving from the deduction of interest payments from the tax base, hence reducing the ETR.

5 Data

Figures 1 and 2 provide a picture of how taxation of income from capital has changed in the United States and in the United Kingdom respectively during periods of economic recession, or immediately after, over the last thirty years.[11] Each figure reports the headline corporate tax rate (CIT); top marginal individual tax rates levied on dividend income (PIT+CIT) and capital gains (CGT+CIT); and the net present value of tax depreciation allowances granted on one unit of investment in either plant and machinery or industrial buildings, denoted with NPV(PM) and NPV(IB) respectively.[12] Shaded areas denote years of economic recession, which occurred in both countries in the early 1980s, the early 1990 and during the period 2007-2009, and in the United States alone following the collapse of the speculative dot-com bubble in the early 2000s.[13]

To understand changes in taxation of income from capital occurred during, or following, years of economic recession in the United States and the United Kingdom, it is essential to bear in mind that tax reforms in both countries have been characterised by two well known trends, which are clearly visible in Figures 1 and 2: the steady reduction of tax rates at both corporate and personal level, and the broadening of the corporate tax base brought about by the decline of tax depreciation allowances for capital spending.

If we now focus on specific tax changes during recessions in the United States, we observe that the early 1980s and 2000s periods are characterised by high tax depreciation allowances for investment in plant and machinery, increasing tax depreciation allowances for investment in industrial buildings, and declining tax rates on dividend income and capital gains. No significant changes in the corporate tax system occurred in response to the early 1990s period, since tax rates on corporate and dividend income had been already considerably reduced by

[11] Full details of all tax data employed in this paper are provided in the Annex at the end of the paper.

[12] PIT+CIT and CGT+CIT are measured taking into account tax rates levied on dividend and capital gains at both corporate and personal level, and any form of relief granted to reduce the effect of double taxation.

[13] Recessions are measured by considering time periods elapsing between the start of a peak and the end of a trough in the 1979-2010 time series of the output gap (measured as the percentage deviation of actual real GDP from HP trend GDP) taken from Datastream for both countries. As a result, recessions are identified over the periods 1978Q4-1980Q3, 1981Q1-1982Q4, 1990Q1-1991Q4, 2000Q2-2001Q4 and 2007Q3-2009Q2 for the United States; and over the periods 1979Q2-1981Q2, 1988Q4-1992Q2, and 2008Q1-2009Q3 for the United Kingdom.

the Reagan tax reform in 1986. During the latest recession the main tax change was the increase in tax depreciation allowances for investment in plant and machinery; while tax rates on corporate and dividend income remained unchanged, and capital gains tax rates increased. In the United Kingdom, the early 1980s recession is characterised, as in the United States, by high tax depreciation allowances for investment in plant and machinery and increasing tax depreciation allowances for investment in industrial buildings. Tax rates remained unchanged during the early 1980s recession, but were significantly reduced immediately after. These tax rate cuts were accompanied by simultaneous reduction of tax depreciation allowances for capital spending which had the effect of broadening the tax base. As a result, in the early 1990s recession, the only key corporate tax reform was a temporary increase in tax depreciation allowances for both plant and machinery and industrial buildings. Similarly, the main corporate tax change occurred in the United Kingdom in the 2007-2009 recession was the temporary increase in tax depreciation allowances for plant and machinery.

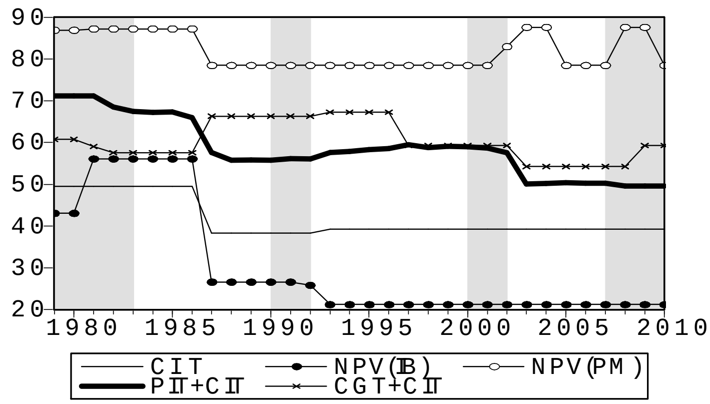

Figure 1: United States, taxation of income from capital, 1979-2010.

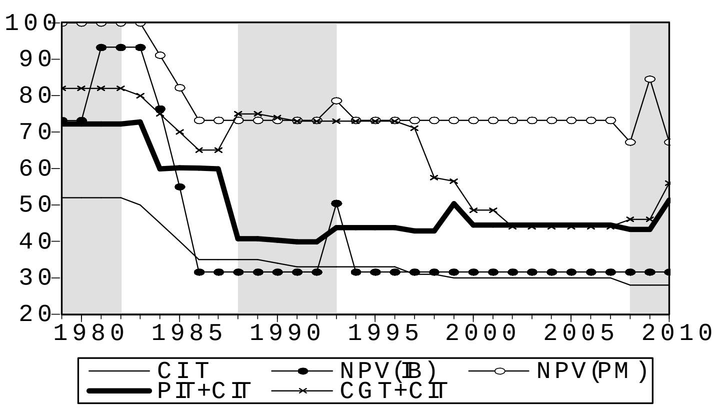

Figure 2: United Kingdom, taxation of income from capital, 1979-2010.

6 Empirical results

6.1 Benchmark case

We provide a quantitative assessment of the analytical results discussed so far, by comparing and contrasting the development of ETRs computed from the constrained and unconstrained models, with a special focus on the impact of corporate tax changes occurred during periods of recessions, or immediately after. We start by setting up a benchmark calibration of the model, based on a domestic investment in plant and machinery, accounting depreciation equal to economic depreciation ($\upsilon = \delta$), and taxation at corporate level alone ($\gamma = 1$). Following Devereux and Griffith (1998b, 2003), we assume that plant and machinery depreciate at 12.25 per cent on a declining balance basis, the real interest rate is 10 per cent, the inflation rate is 3.5 per cent and absence of taxes on interest income ($\rho = i$). We carry out the benchmark computation under the assumption that investment can earn either a low or a high rate of financial return, corresponding with p equal to either 10 or 100 per cent respectively.

Figures 3 and 4 plot ETRs in the United States computed from the unconstrained and the constrained model for this benchmark case when investment is financed with retained earnings and debt respectively.[14] In both figures we also plot the statutory tax rate on corporate income (STR) which in the case of taxation at corporate level only corresponds with CIT.

Three main features can be observed for the United States. First, changes in investment profitability have a larger impact under the unconstrained model, which tends to overstate the effect on the base of depreciation allowances: indeed for retained earnings finance, the average percentage ETR obtained from the unconstrained model is 16.4 for low return investment and 39.2 for high return investment; whereas, the constrained model predicts average percentage ETRs of 41.1 and 41.6 respectively. Similarly, for debt financed investment, we observe that the gap between the average ETRs is about 67 per cent under the unconstrained model and 50 per cent under the constrained model.

Second, under retained earnings finance, the standard analysis suggests that low return investment project benefit significantly more than high return projects from TBIs temporarily granted in the United States in the early 1980s, 2000s and in the late 2000s. In contrast, TBIs have little effect on the ETR under the constrained model, regardless of the level of investment profitability.

Third, under debt financing, TBIs appear to have little impact on the ETR, which instead responds significantly to TRIs: in fact, under both models the ETR display a significant shift following the corporate income tax rate cuts occurred in both countries during the mid 1980s. However, the direction of this shift predicted by the two models is considerably different. We recall from the

[14] As noted above, when considering taxation at corporate level alone, the ETR for retained earnings finance is equal to that under new equity finance.

previous sections that a TRI reduces the benefit of debt financing by decreasing (i) the value of interest rate deduction from the corporate income tax base and (ii) the present discounted value of the tax saving generated by capital allowances: both these effects tend to increase the ETR. On the other hand, a TRI reduces the tax levied on the rate of return generated by the investment, in turn reducing the ETR. When investment profitability is low, this latter effect is more than compensated by the former two: hence the ETR on low return investment increases from -47.3 to -27.4 per cent in the unconstrained model and from -17.2 to 12.9 per cent in the constrained model. However, for high profitable investment the opposite effect occurs, and the ETR declines from 39.9 to 31.8 per cent in the unconstrained model and from 42.9 to 33.2 in the constrained model.

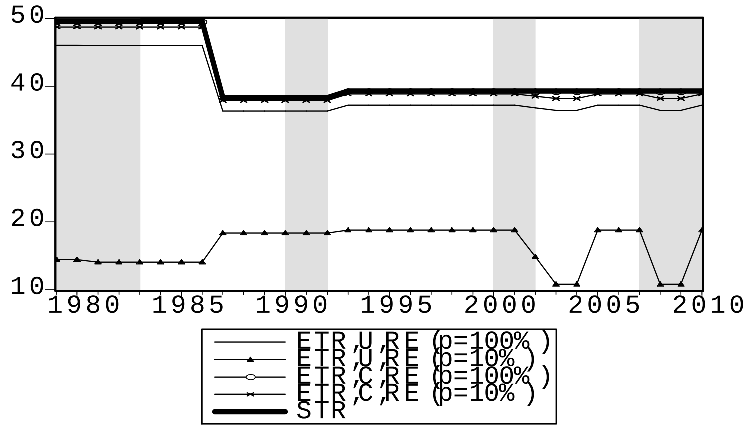

Figure 3: United States, ETR on domestic investment in plant and machinery financed by retained earnings, taxation at corporate level only, 1979-2010.

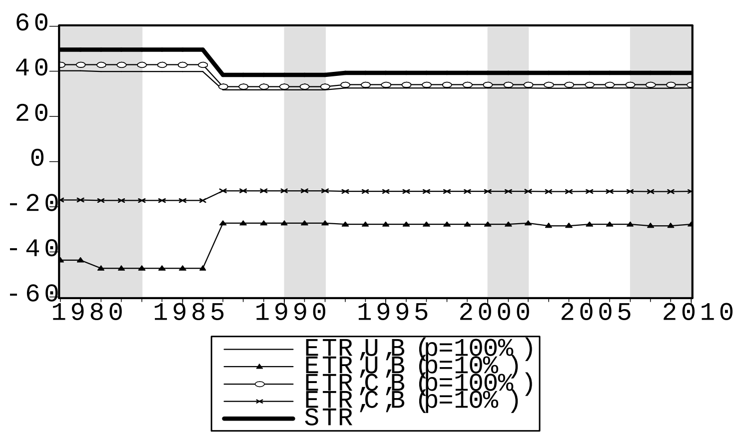

Figure 4: United States, ETR on domestic investment in plant and machinery financed by debt, taxation at corporate level only, 1979-2010.

Figures 5 and 6 shows that similar patterns can be observed also for the United Kingdom: the standard analysis significantly amplifies the variation of the ETRs over investment profitability for both retained earnings and debt finance; overstates the benefit of temporary TBIs, especially when investment is financed by retained earnings and yields a low rate of return.

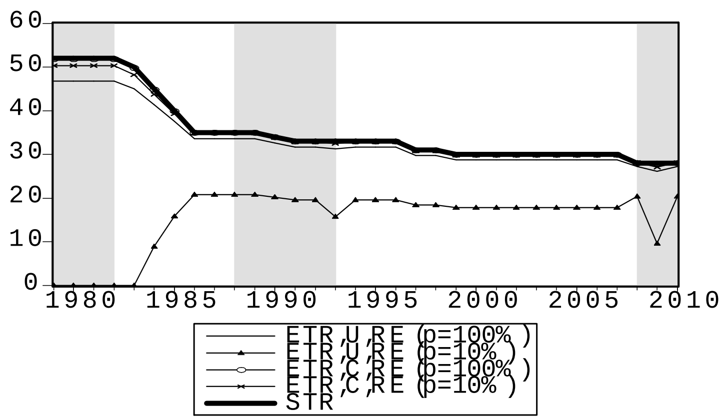

Figure 5: United Kingdom, ETR on domestic investment financed in plant and machinery by retained earnings, taxation at corporate level only, 1979-2010.

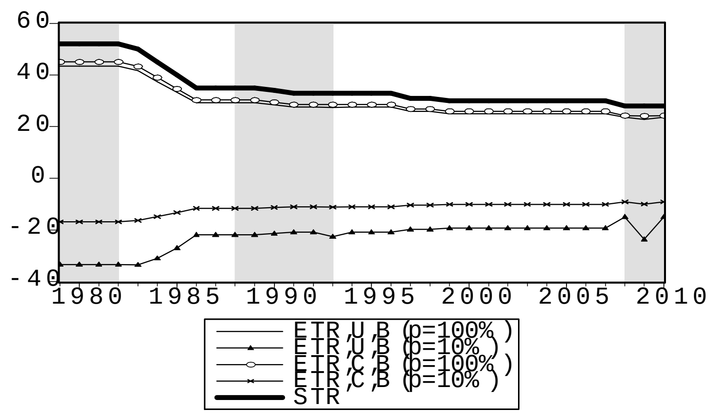

Figure 6: United Kingdom, ETR on domestic investment financed in plant and machinery by debt, taxation at corporate level only, 1979-2010.

6.2 Robustness analysis

The previous evidence suggests that, after taking into account constraints on dividend policy determined by accounting rules, TRIs are more effective in reducing the ETR than TBIs. We next explore the robustness of this proposition along a number of dimensions. In particular, we examine the impact of taxation at shareholders level ($\gamma \neq 1$); the effect of investment in alternative types of assets such as industrial buildings; and the effect of accounting depreciation different from economic depreciation ($\upsilon \neq \delta$).

6.2.1 Personal taxation

We introduce personal taxes, and consider a domestic investment in plant and machinery, which earns a rate of return p of 40 per cent and it is financed by either retained earnings or new equities or debt. Hence, we add to the previous analysis the effect of top marginal tax rates on dividend income and capital gains levied at shareholders level and the integration system between taxation at corporate and personal level. Our results are graphed in Figure 7 for the United States and Figure 8 for the United Kingdom. In both figures, STR denotes the headline tax rate at shareholders level. We observe the following features.

First, ETRs increase in both countries when considering taxation at shareholder level since neither the United States nor the United Kingdom provide full integration for the double taxation at corporate and personal level of capital income. Second, ETRs measured from the constrained model are always above those obtained from the unconstrained model for each type of investment finance. Third, in both countries the intertemporal evolution of the ETR appear to follow the pattern of the combined effective tax rate (STR) regardless of the form of investment finance. Fourth, even when considering taxation at personal level, the unconstrained model appear to overstate the effect of TBIs on the ETRs. For instance, the constrained model shows that the increase in tax allowances granted in the United States during the last recession lead to a percentage reduction of the ETR of 1.5 under retained earnings finance, 2.8 under new equity finance, and 1.9 under debt finance, while the constrained model predicts percentage reductions of 3.4, 4.9 and 2.2 respectively. Similarly, in the United Kingdom, the increase from 20 to 40 per cent of tax depreciation allowances granted in the 2009 HM Budget Revenue lead to a percentage reduction in the ETR of 0.2, 0.3 and 0.2 for retained earnings, new equity and debt finance respectively, while the constrained model predicts that the reduction was instead of 2.3, 2.6 and 1.8 per cent respectively. In contrast, a significant decline of the ETR can be observed in both countries as a result of the decline of the combined statutory tax rate, as for example in the United States following the Reagan tax reform in the mid 1980s and the recession of early 2000s; and in the United Kingdom during the 1980s. Finally, we notice that under the constrained model ETRs for investment financed by new equity are above the STR from 1979 to 1986 in the United States, and from 1979 to 1983 in the United Kingdom. In both countries, during these periods of time, the value of the parameter γ is less than one, since taxation of dividend income was higher relative to capital gains. This implies that new equity finance was a less efficient form of investment finance, hence the ETRs for new equity is systematic above the corresponding measure for retained earnings finance. The extra burden of new equity finance is particularly relevant during the first half of the 1980s, since in both countries top marginal tax rates on dividend income were extremely high and partial (United Kingdom) or no relief (United States) for double taxation was granted to shareholders. This results in ETRs above the STR under the constrained model. In the unconstrained model this effect is mitigated by the fact that shareholders still benefit from the distribution of the tax saving generated from tax depreciation allowances, while this does not occur under the constrained model, which does not allow cash flow distribution to shareholders out of TBIs. The reductions in the combined tax rates occurred in the United States in 1987 (from 66.01 to 57.59 per cent) and in the United Kingdom in 1984 (from 72.77 to 59.89) are significant enough to reduce the cost of new equity finance relative to retained earnings, hence reducing the corresponding ETR for new equity finance below the STR.

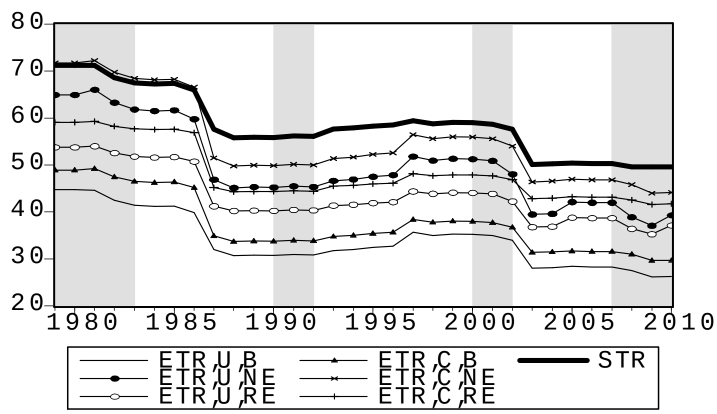

Figure 7: United States, ETR on domestic investment in plant and machinery financed, p=40%, taxation at shareholders level, 1979-2010.

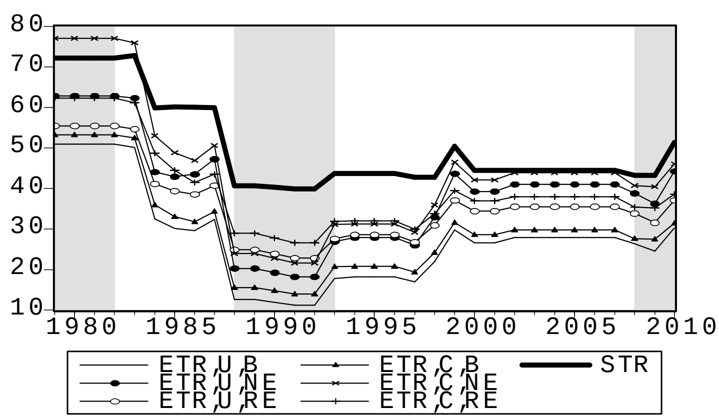

Figure 8: United Kingdom, ETR on domestic investment in plant and machinery financed, p=40%, taxation at shareholders level, 1979-2010.

6.2.2 Industrial buildings

We extend our analysis of the benchmark scenario to compute ETRs on domestic investment in industrial buildings. In particular, Figures 9 and 10 consider ETRs on industrial buildings investment financed by retained earnings and debt in the United States, while Figures 11 and 12 consider the corresponding ETRs in the United Kingdom.

The constrained model shows that ETRs in the United States on domestic investment in industrial buildings financed by retained earnings follow the dynamic patters of the statutory tax rate and show little response to TBIs. As for the case of plant and machinery, the benefit of higher tax depreciation allowances granted during the early 1980s recession is largely overstated by the standard analysis, and significantly dependent on the level of investment profitability under the standard model. Notice how the constrained model predicts ETRs on industrial buildings above the statutory tax rate for the whole period 1979-2010, while ETRs are predicted to be above the STR from 1987 onward under the unconstrained model. This is because until 1987, the ETR under the unconstrained model is already close to the headline STR. Hence, once the benefit of tax depreciation is removed by the constrained model, the ETRs is marginally above the headline rate. After 1987, the tax depreciation allowance rate on investment in industrial buildings is reduced in the United States to 3 per cent, which is therefore lower than the 4 per cent rate of economic depreciation for investment in industrial buildings assumed in the simulation. As a result of having tax depreciation allowances which do not fully cover economic depreciation, shareholders face a cost of capital higher than 1 since 1987, which leads to ETRs higher than the STR. This effect is further exacerbated in the constrained model as shareholders pay anticipated taxes. The gap between the ETRs and the STR on industrial buildings further increases after the tax depreciation allowance rate is further reduced to 2.6 per cent in 1993.

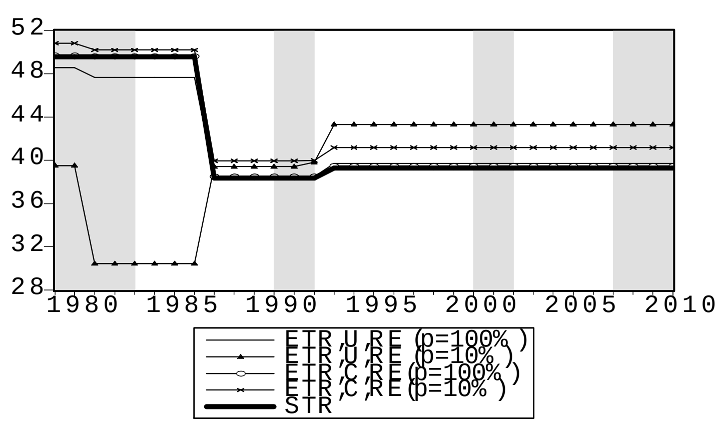

Figure 9: United States, ETR on domestic investment in industrial buildings financed by retained earnings, taxation at corporate level only, 1979-2010.

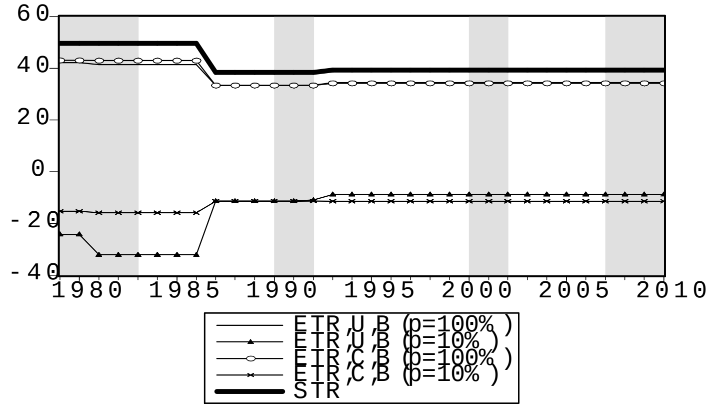

Figure 10: United States, ETR on domestic investment in industrial buildings financed by debt, taxation at corporate level only, 1979-2010.

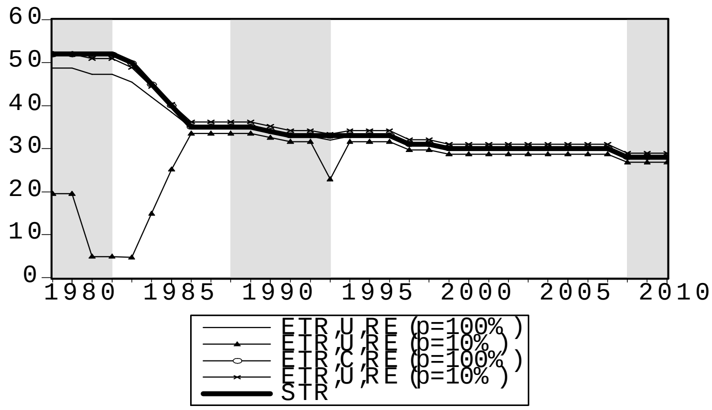

Figure 11: United Kingdom, ETR on domestic investment in industrial buildings financed by retained earnings, taxation at corporate level only, 1979-2010.

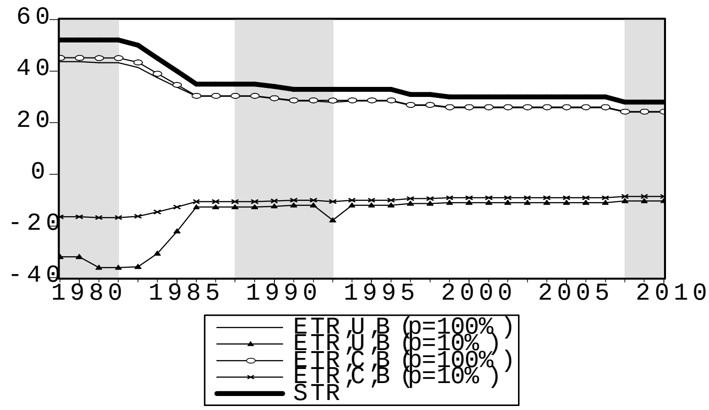

Figure 12: United Kingdom, ETR on domestic investment in industrial buildings financed by debt, taxation at corporate level only, 1979-2010.

6.2.3 Change in accounting depreciation

Figures 13 and 14 complete the empirical analysis for the United States and the United Kingdom by relaxing the assumption that accounting depreciation equals economic depreciation. This is accomplished by retaining the assumption that both accounting and economic depreciation are computed on a declining balance basis, and then changing the accounting depreciation rate while keeping constant the rate of economic depreciation. We consider the case of domestic investment in plant and machinery earning a financial return of 40 per cent. Changes in the accounting depreciation rate have no effect in the unconstrained model, while under the constrained model they impact on the size of provisions for deferred taxes accumulated over time by firms. For both countries, we compute ETRs when $\upsilon = 0$, 10 and 20 per cent; and report the corresponding measures obtained when $\upsilon = \delta$ and under the unconstrained model. As pointed out in the analytical section, the sign of provisions for deferred taxes depends on the difference between tax and accounting depreciation, and it is not affected by economic depreciation. Hence, given economic and tax depreciation, a reduction of the accounting depreciation rate has the effect of increasing the size of provisions for deferred taxes, hence the measure of the ETR obtained from the constrained model. Vice-versa, the effect of an increase in the rate of accounting depreciation reduces the ETR as it decreases the size of provision for deferred taxes. As the rate of accounting depreciation becomes significantly higher than the rate of economic depreciation ETR falls below the STR. All these effects are clearly visible in the two figures below. Most importantly, we notice that all our previous evidence on the greater effectiveness of TRIs relative to TBIs in reducing the ETR on income from capital during periods of economic recessions are still valid, regardless of the assumption on the rate of accounting depreciation.

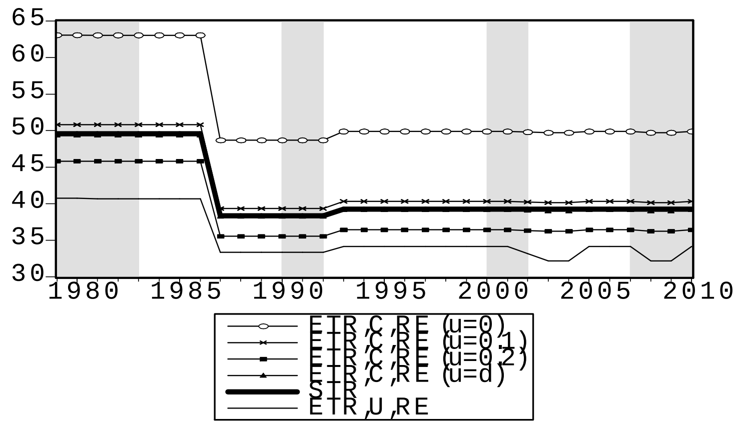

Figure 13: United States, ETR on domestic investment plant and machinery financed by retained earnings under alternative accounting depreciation rates, taxation at corporate level only, 1979-2010.

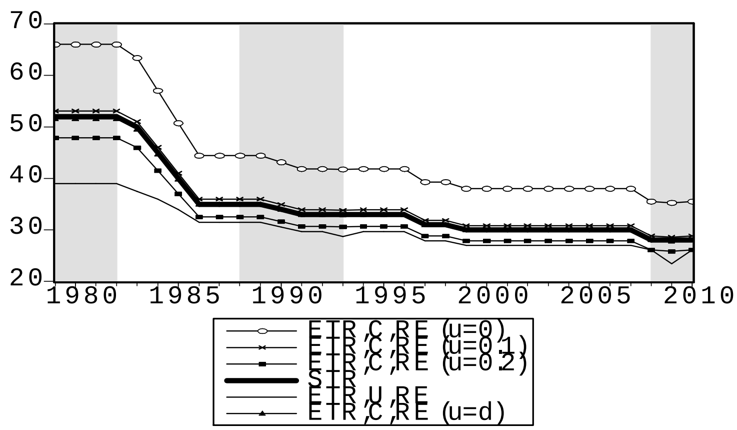

Figure 14: United Kingdom, ETR on domestic investment plant and machinery financed by retained earnings under alternative accounting depreciation rates, taxation at corporate level only, 1979-2010.

7 Conclusions

This paper analyses the effectiveness of corporate tax incentives in reducing the tax burden on income from capital. We compare tax base and tax rate incentives within an investment model obtained by incorporating financial constraints on dividend policy into the framework for the computation of the ETR devised by Devereux and Griffith (1998b, 2003). The need of considering financial constraints on dividend income when comparing tax rate and tax base incentives in tax policy analysis arises because most of tax base incentives are temporary in nature and result in deferred taxation. Accounting rules in both the United States and the United Kingdom prevent cash flows resulting from deferred taxes to be distributed to shareholders. Hence, omission of the constraints would result in an incorrect assessment of the effect of tax incentives and their implications for the measurement of the tax burden on investment.

We re-compute time series of the ETR under the new constrained model in both the United States and the United Kingdom over the period 1980-2010. The new empirical results show - in sharp contrast with the existing evidence - that tax rate incentives are far more effective in reducing the ETR than tax base incentives. This result holds regards to the form of investment finance, the type of capital spending and the value of economic depreciation relative to accounting depreciation. Also, our analysis warns policy makers about a potential negative implication of current trends in corporate tax rates: as corporate tax rates continue to decline over time, there will be less and less scope to employ the most effective tax instrument, the corporate tax rate, to reduce the effective tax burden on income from capital during periods of economic recessions or downturns. In turn, this suggests that corporate tax rate cuts should also be temporary.

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A Tax data

Tables 1 and 2 report all tax data used in the empirical section of this paper. CIT denotes the statutory corporate income tax rate, inclusive of surcharges and local tax rates, where they exist. NPV(PM) and NPV(IB) denotes the discounted present value of tax depreciation allowances on one unit of capital spending in plant and machinery and industrial buildings respectively. PIT is the top marginal individual tax rate on dividend income and c denotes the relief granted to reduce the effects of double taxation. In particular, we notice that a classical system (no relief for double taxation) is employed in the United States throughout the whole sample period, whereas a credit system is used in the United Kingdom, with imputation rate declinging from 42.9 per cent in 1979 to 11.1 per cent in 2010. CGT is the top marginal tax rate on capital gains, while g measures the percentage of the gain chargable after taking into account any form of double taxation relief. A 60 per cent exemption was granted on capital gains in the United States from 1979 to 1986, and no relief for double taxation was available afterwards. Relief for double taxation of capital gains on qualified participations is granted in the United Kingdom from 1998 to 2007. In table 2, the percentage of chargable capital gain is computed after measuring the average value tapering relief each year. Finally, the rate Z is the the accruals-equivalent capital gains tax rate, measured by making the assumption that, following an increase in the value of an asset, the investor sells 10 per cent of his remaining holding in each period.

Table 1: Capital income taxation data, United States, 1979-2010

year	CIT	NPV(PM)	NPV(IB)	PIT	c	CGT	g	Z
1979	49.6	86.9	43.1	42.9	0	28	40	7.9
1980	49.6	86.9	43.1	42.9	0	28	40	7.9
1981	49.6	87.3	56.1	42.9	0	23.7	40	6.7
1982	49.6	87.3	56.1	37.7	0	20	40	4.7
1983	49.6	87.3	56.1	35.6	0	20	40	4.7
1984	49.6	87.3	56.1	35.1	0	20	40	4.7
1985	49.6	87.3	56.1	35.3	0	20	40	4.7
1986	49.6	87.3	56.1	32.6	0	20	40	4.7
1987	38.4	78.5	26.6	31.2	0	28	0	15.1
1988	38.4	78.5	26.6	28.2	0	28	0	14.0
1989	38.4	78.5	26.6	28.4	0	28	0	14.0
1990	38.4	78.5	26.6	28.3	0	28	0	14.0
1991	38.4	78.5	26.6	28.9	0	28	0	14.3
1992	38.4	78.5	25.8	28.7	0	28	0	14.3
1993	39.3	78.5	21.2	30.2	0	28	0	15.2
1994	39.3	78.5	21.2	30.6	0	28	0	15.2
1995	39.3	78.5	21.2	31.3	0	28	0	15.2
1996	39.3	78.5	21.2	31.7	0	28	0	15.2
1997	39.3	78.5	21.2	33.2	0	20	0	10.9
1998	39.3	78.5	21.2	32.1	0	20	0	10.9
1999	39.3	78.5	21.2	32.6	0	20	0	10.9
2000	39.3	78.5	21.2	32.5	0	20	0	10.9
2001	39.3	78.5	21.2	32.0	0	20	0	10.8
2002	39.3	83.0	21.2	30.1	0	20	0	10.8
2003	39.3	87.6	21.2	17.8	0	15	0	7.9
2004	39.3	87.6	21.2	18.0	0	15	0	7.9
2005	39.3	78.5	21.2	18.3	0	15	0	7.9
2006	39.3	78.5	21.2	18.1	0	15	0	7.9
2007	39.3	78.5	21.2	18.1	0	15	0	7.9
2008	39.3	87.6	21.2	17	0	15	0	7.9
2009	39.3	87.6	21.2	17	0	20	0	10.5
2010	39.3	78.5	21.2	17	0	20	0	10.5

Notes: All data are in percentage. CIT=corporate income tax rate; NPV(PM)=net present value 1 unit investment in plant and machinery; NPV(IB)=net present value 1 unit investment in industrial buildings; PIT=Top marginal individual tax rate on dividend income; c=imputation rate on dividend income; CGT=capital gains tax rate; g=proportion of chargable gain; Z=effective tax rate on accrued capital gains. Sources: Citizens for Tax Justice (www.ctj.org); Devereux et al. (2007); Institute for Fiscal Studies, International Tax Data (www.ifs.org.uk); and OECD Tax Database (www.oecd.org).

Table 2: Capital income taxation data, United Kingdom, 1979-2010

year	CIT	NPV(PM)	NPV(IB)	PIT	c	CGT	g	Z
1979	52	100.0	73.2	75	42.9	30	0	19.3
1980	52	100.0	73.2	75	42.9	30	0	19.3
1981	52	100.0	93.2	75	42.9	30	0	19.3
1982	52	100.0	93.2	75	42.9	30	0	19.3
1983	50	100.0	93.2	75	42.9	30	0	19.3
1984	45	91.1	76.4	60	42.9	30	0	19.3
1985	40	82.2	55.0	60	42.9	30	0	19.3
1986	35	73.3	31.6	60	40.8	30	0	19.3
1987	35	73.3	31.6	60	37.0	30	0	19.3
1988	35	73.3	31.6	40	33.3	40	0	21.8
1989	35	73.3	31.6	40	33.3	40	0	21.8
1990	34	73.3	31.6	40	33.3	40	0	21.8
1991	33	73.3	31.6	40	33.3	40	0	21.8
1992	33	73.3	31.6	40	33.3	40	0	21.8
1993	33	78.6	50.4	40	25.0	40	0	21.8
1994	33	73.3	31.6	40	25.0	40	0	21.8
1995	33	73.3	31.6	40	25.0	40	0	21.8
1996	33	73.3	31.6	40	25.0	40	0	21.8
1997	31	73.3	31.6	40	25.0	40	0	21.8
1998	31	73.3	31.6	40	25.0	40	66.3	14.5
1999	30	73.3	31.6	40	11.1	40	66.3	14.5
2000	30	73.3	31.6	32.5	11.1	40	46.3	10.1
2001	30	73.3	31.6	32.5	11.1	40	46.3	10.1
2002	30	73.3	31.6	32.5	11.1	40	35	7.6
2003	30	73.3	31.6	32.5	11.1	40	35	7.6
2004	30	73.3	31.6	32.5	11.1	40	35	7.6
2005	30	73.3	31.6	32.5	11.1	40	35	7.6
2006	30	73.3	31.6	32.5	11.1	40	35	7.6
2007	30	73.3	31.6	32.5	11.1	40	35	7.6
2008	28	67.3	31.6	32.5	11.1	18	0	9.8
2009	28	84.6	31.6	32.5	11.1	18	0	9.8
2010	28	67.3	31.6	42.5	11.1	28	0	16.5

Notes: All data are in percentage. CIT=corporate income tax rate; NPV(PM)=net present value 1 unit investment in plant and machinery; NPV(IB)=net present value 1 unit investment in industrial buildings; PIT=Top marginal individual tax rate on dividend income; c=imputation rate on dividend income; CGT=capital gains tax rate; g=proportion of chargable gain; Z=effective tax rate on accrued capital gains. Sources: Devereux et al. (2007); HMRC (www.hmrc.gov.uk); Institute for Fiscal Studies, International Tax Data (www.ifs.org.uk); and OECD Tax Database (www.oecd.org).