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Efficient Economic Rent Taxation under a Global Minimum Corporate Tax

Abstract

The international agreement on a corporate minimum tax is a milestone in global corporate tax arrangements. The minimum tax disturbs the equivalence between otherwise equivalent forms of efficient economic rent taxation: cash-flow tax and allowance for corporate equity. The marginal effective tax rate initially declines as the statutory tax rate rises, reaching zero where the minimum tax is inapplicable, and increases thereafter. This kink occurs at a lower statutory rate under cash-flow taxation. We relax the assumption of full loss offset; provide a routine for computing effective rates under different designs; and discuss policy implications of the minimum tax.

JEL-Codes: H210, H250, F230.

Keywords: investment, minimum taxation, corporate tax reform, international taxation, rent tax.

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1 Introduction

The G-20/OECD-led 'Inclusive Framework' agreement to establish a minimum effective corporate tax rate of 15 percent (known as 'Pillar Two') is a path-breaking modification to the century-old international corporate tax arrangements. With implementation underway, to understand the ramifications of this agreement, recent studies haven been centered around the important question of how the implementation of a minimum tax would alter tax competition and profit shifting.[1] Equally important—albeit left without scrutiny thus far—is the question of how a binding minimum tax affects investment and the domestic design of profit taxes. In particular, how does the minimum corporate tax alter the familiar features of efficient economic rent taxation? These questions are the focus of this paper.

Scholars have long advanced ideas for a profit tax design that avoids the common distortions of existing corporate income tax (CITs). These distortions manifest themselves in: (i) investment distortions (some investments worth undertaking without a tax become unviable–or unprofitable investments viable—in the presence of the tax); and (ii) debt bias (debt financing is tax-favored to equity financing due to the deductions of interest expenses without allowing analogous deductions for equity returns). The corporate tax reforms proposed by, for example, Mirrlees Review (2011), IFS Capital Taxes Group (1991), and Meade Committee (1978), among many others, all share the theme of leaving the normal return (the opportunity cost of the investment) untaxed while taxing economic rent (returns over and above the normal returns).

Efficient economic rent taxation broadly falls under two classes of models. The first is cash-flow taxes. One form is the R-based cash-flow tax that provides immediate expensing of capital investment (that is, immediate 100 percent depreciation) while eliminating both interest deductions and the taxation of interest income.[2] Notably, the United States and the UK provide immediate expensing, although both still allow interest deductions. The second class of efficient rent taxation provides tax allowances for the normal return. Specifically, the allowance for corporate equity (ACE) maintains interest deductions and depreciation while providing notional deductions to equity returns. The ACE is proposed by the European Commission (2022) in a draft EU Directive known as 'Debt–Equity Bias Reduction Allowance' (DEBRA).

[1] Several studies look at welfare implications of the minimum tax, including Haufler and Kato (2024), Hebous and Keen (2023), Janeba and Schjelderup (2023), and Johannesen (2022), building on the rich tax competition literature surveyed in Keen and Konrad (2013).

[2] In the Appendix, we also show the equivalence between the R-based, R+F-based, and S-based cash-flow tax. The base of the latter is net distributions, whereas the R+F cash-flow tax defines the base as net real transactions plus net financial transactions.

Despite the different design details of the two classes of efficient rent taxation models, a fundamental result is that both are equivalent in net present value term and achieve the same outcome of eliminating both types of aforementioned distortions.[3] We establish this equivalence in the absence of a minimum tax. This derivation is the backbone of the analysis to enable a consistent comparison between pre- and post-minimum taxation and provide a comprehensive overview of how the different profit tax designs impact investment. It is also worth noting that this result has not yet been presented with explicit expressions for the effective taxation of economic rent under various assumptions.

We use a dynamic investment model to derive the forward-looking effective tax rates for the CIT, the cash-flow tax, and the ACE under a minimum tax. Forward-looking effective tax rates—pioneered by Devereux and Griffith (1998, 2003) and King (1974)[4]—have become the standard analytical tool to evaluate the effects of taxes on investment, frequently drawn upon by policy institutions, as for example in Congressional Budget Office (2017), Department of the Treasury (2021), OECD (2023), and Oxford CBT (2017), inter alia. Beyond the statutory tax rate, forward-looking effective tax rates take into account tax base provisions (notably depreciation and the treatment of losses) over the entire horizon of the investment. If the marginal effective tax rate (METR) is zero, the pre- and post-tax *normal* returns are the same (retaining investment efficiency). The average effective tax rate (AETR) measures the net present value of the tax on economic rent, and it is important for the discrete investment location choice of multinational enterprises. We show that both the ACE and R-based cash-flow tax result in a zero METR and an identical AETR for the same rent-yielding investment. The zero-METR result under both systems stands in contrast to the CIT that distorts investment and financing decisions.[5]

The key insight of this paper is that a minimum tax akin to Pillar Two breaks the equivalence between cash-flow taxation and the ACE. We show that under both systems the minimum tax can fall on the normal return. Overall, however, under minimum taxation the R-based cash-flow tax either maintains its non-distorting features or results in lower distortion than the ACE, ceteris paribus. Specifically, there are three regions: (i) one where the minimum tax applies in both cases,

[3]An excellent discussion of this equivalence is in Boadway and Keen (2010).

[4]See, also, for example, Hall and Jorgenson (1967) and King and Fullerton (1984).

[5]The discussion here focuses on origin-based rent taxation since it is the prevailing form of CITs and given the imminent implications of Pillar Two for tax policy. Theoretically, rent taxation can be destination-based akin to value-added taxes (see, for example, Auerbach and Devereux, 2018, Devereux et al., 2021, and Hebous and Klemm, 2020). Under such border-adjustment, the source of eliminating both the investment distortion and the debt bias remains either the ACE or the cash-flow tax (that is, if the METR is zero under an origin-based system, it remains zero with a border-adjustment). The role of the border-adjustment is to eliminate international downward pressures on tax rates and incentives for profit shifting.

and the amount of the tax and the METR are higher under the ACE than under the cash-flow ; (ii) a region where the minimum tax applies only in the case of the ACE, and thus the METR is zero for the cash-flow tax but not for the ACE; and (iii) a region where the minimum tax is not biding under both systems, for sufficiently high CIT rates (generally well above 15 percent), and hence the equivalence between them is restored.

To uncover the driver of this key result we need to spell out Pillar Two rules. The minimum tax proceeds in two steps. First, the rate is determined, and it is strictly positive if the ratio of (covered) taxes to (covered) profit is below a threshold (15 percent in the agreement).[6] We will refer to this ratio here as the Pillar Two effective rate $\left(\frac{T_t^c}{\pi_t^c}\right)$.[7] If in year t, for example, this ratio is 5 percent, then the top-up tax rate is 10 percent. Second, the tax base is determined as (covered) profit excluding a portion that is set to 5 percent of each tangibles and payrolls (after a transition period). This portion is called substance-based income exclusion (SBIE); thus the top-up base is: $\pi_t^c - SBIE_t$. Hence, the minimum tax *amount* is strictly positive if both the top-up rate and the top-up base are strictly positive.

Under the minimum tax, for the ACE, neither the top-up rate nor the top-up base can go below that of the cash-flow tax, ceteris paribus. The reason is that Pillar Two treats them differently. The nature of this differential treatment implies no changes to the top-up rate or base under immediate expensing of investment (differently from the ACE). Particularly, immediate expensing is considered as a 'temporary timing measure' giving rise to an upward adjustment to covered taxes; that is, the rules consider the reduced tax in a specific year 'as if' it were paid, leaving the Pillar Two effective rate unchanged.[8] This means, immediate expensing per se does not trigger a top-up tax. In contrast, the ACE itself can prompt a top-up tax because the allowance is added to the profit, thereby lowering the Pillar Two effective rate that becomes $\frac{T_t^c}{\pi_t^c + ACE_t}$. This treatment raises also the top-up base because the top-up rate will apply to income tax base of $\pi_t^c + ACE - SBIE_t$.[9] After all, whenever the top-up binds under the R-based cash-flow tax, it must bind under ACE; but

[6] Profit is referred to as 'GloBE Income' in the agreement, which is accounting profit after some adjustments; for example, deducting dividends received from related parties since these are typically exempt from the CIT. 'Covered' taxes indicate adjustments to obtain taxes attributable to income (for example, sales taxes are not 'covered' taxes for the purpose of the calculation).

[7] To avoid confusion, we note upfront that Pillar Two effective rate is an average tax rate (that is, tax payment over income) and not a forward-looking effective rate typically used in economic analysis.

[8] The upward adjustment reflects the temporary difference between the accounting and tax recognition (Article 4.4 in OECD, 2021).

[9] The refunded ACE acts like a 'qualified refundable tax credit' under Pillar Two, which means the allowance is added to covered income. If, alternatively, it is not refunded, then the ACE lowers the covered tax, thereby lowering the numerator of the Pillar Two effective rate. We show that the top-up tax is then higher. In addition, to start with, recall that the ACE would not be efficient without refunding tax losses even without a minimum tax.

it may bind under ACE while not being binding for the R-based cash-flow tax.

There is a caveat to the (non)equivalence results. If the SBIE is very large over the entire duration of the investment[10], the top-up base is zero for all years under any system, thereby eliminating the minimum tax altogether. While this particular situation restores efficiency for both the ACE and cash-flow tax systems, it is driven by a project specific variable that depends on the decomposition of assets and labor. An efficient rent tax should be neutral with respect to any decomposition of assets, maintaining a zero METR on any investment irrespective of project characteristics or firm characteristics.

To shed more light on the key finding, we delve deeper into the mechanisms of efficiency. The above analysis considers the ACE and the R-based cash-flow tax as they are designed in theory, particularly both fully refunding tax losses, or equivalently carrying over the tax value of losses with interest.[11] Without a full loss offset, both the ACE and the R-based cash-flow tax lose investment efficiency and, as we show, the equivalence breaks even without a top-up tax. As of May 2024, Pillar Two rules do not explicitly specify the treatment of either approach. Throughout the paper, the baseline maintains that Pillar Two simply ignores such a measure; that is, either receiving interests on the loss carryover or receiving refunds is considered as a timing measure that does not affect the Pillar Two effective rate. This approach gives lower bounds for the METRs/AETRs under a top-up tax. Another possibility is to view the tax loss refunds as a tax credit (which would lower Pillar Two effective rate). Under this scenario, we find that generally the ACE turns out to give lower effective tax rates than the R-based cash-flow tax because its refunds are spread over more years, which lowers top-up tax amounts. Either way, the minimum tax makes the systems nonequivalent and the treatment of losses will have tangible consequences for the tax on investment. We provide a routine for a numerical solution of the METRs and AETRs, enbaling a consistent comparison under a CIT, ACE, or cash-flow tax (with or without a minimum tax), relaxing the 'full loss offset' assumption altogether.[12]

The findings reported here are policy relevant and can be looked at in two complementary ways to: (i) guide how countries can react to the minimum tax via domestic tax base and rate choices, given Pillar Two rules; and (ii) indicate how to improve the design of a minimum tax. On the former, for example, generally a statutory CIT rate below 15 percent likely implies taxing the

[10]Note that the SBIE of the project decreases over time due to depreciation of tangibles, given labor. In the rules, the SBIE is at the firm level.

[11]The design in Meade Committee (1978) is immediate refunding on tax losses, whereas equivalently in Garnaut and Ross (1975) it is an unlimited carry-forward of losses while bearing interest (under the name of 'resource rent tax').

[12]Without a full loss offset, there are no closed form expressions for the METRs or AETRs.

normal return because of the binding minimum tax (unless, for example, combined with refundable tax credits). Superior options for investment efficiency include combining a statutory rate of at least 15 percent with an R-based cash-flow tax to prevent the top-up tax and generate a zero METR.[13] Some countries like the US and the UK offer full immediate expensing while allowing some interest deductions and the carry-forward of losses without interest (Adam and Miller, 2023).[14] Such design is not equivalent to the R-based cash-flow tax. We show that interest deductions compensate for the unavailability of loss refunds. Thus, combining immediate expensing with interest deductions may lead to a zero METR, rather than a negative METR as one may be tempted to conclude. However, this comes at the cost of debt bias as such a system favors corporate leverage.

The deeper underlying policy implication from our study is that an efficient design of a minimum tax should fall on economic rent only. To achieve this, the top-up tax base should ideally relieve the normal return from the minimum tax (which is generally different from the SBIE). While the temporary timing approach of Pillar Two is an elegant way to preserve the time value of immediate expensing, our analysis suggests that to retain efficiency under a minimum tax, the top-up base can be defined as 'EBIT minus investment' (allowing carryforward). Such a 'cash-flow alike' top-up base makes the minimum tax compatible with any efficient rent tax designs (thereby maintaining tax equivalences) and eliminates debt bias.[15]

Finally, one further result worth highlighting from the model presented here relates to resolving a puzzling and recurring observation in the applied literature of forward-looking effective tax rates. This is not a mere by-product of the analysis, but rather goes to the heart of establishing a consistent systematic comparison. In particular, numerous studies have reported negative METRs for ACE systems (including, Congressional Budget Office, 2017; Department of the Treasury, 2021; OECD, 2023; and Project for the EU Commission, 2022). A negative METR stands in contrast to the theoretical predication that it should be zero under an efficient rent tax. Although it can occur in practice if, for instance, countries provide a higher allowance than the normal return, without explicit deviations from theory, the default model must predict a zero METR under the ACE (or a cash-flow tax).[16] The common practice has been unable to be consistent with theory

[13] Further elements that shape country responses to Pillar Two can be found, for example, in Hebous et al. (2024).

[14] There are real-life exceptions, though, where refunds for (or interest on) tax losses are provided, for instance, in rent tax regimes for natural resources in Australia, Ghana, and Norway (Hebous et al., 2022).

[15] A completely alternative route is, for example, to design a minimum tax under a formulary apportionment allocating economic rent to market countries and imposing a minimum tax on that rent, while not taxing normal return. Studies that look at approaches of formulary apportionment include Clausing (2016) and Beer et al. (2023), although they do not explicitly discuss a minimum tax on the reallocated rent. Also, note that the need for an internationally set minimum tax under these destination-based reforms is diminished to the extent that tax competition is reduced.

[16] Additionally, tax losses are typically not refundable. Thus, the METR for the ACE under a non-refundable CIT

mainly because of ignoring the depreciated value of the equity in the first period, and thus the model would unintentionally amplify the value of the allowance (providing the allowance to an amount exceeding the *book value of equity*).[17] Numerical illustration using prototypical parameterization suggests that the amplification of the ACE base can easily underestimate the METR by multiple percentage points (yielding negative values instead of zero). This underestimation also implies that the AETRs—corresponding to all levels of profitability (and specifically for low-return investments)—would be underestimated too.

The rest of the paper is structured as follows. Section 2 presents a permanent investment model of METRs and AETRs for a standard CIT under a minimum tax similar to Pillar Two. Section 3 presents an R-based cash-flow tax under a minimum tax. Section 4 establishes the equivalence between the ACE and the R-based cash-flow tax and discerns how and when the equivalence is abolished. Section 5 relaxes the full-refundability assumption. Finally, Section 6 puts all the findings together while Section 7 concludes.

2 Standard CIT

2.1 No Minimum Tax

The starting point is a permanent investment model without taxes.[18] In period 0, consider an investment of I units of capital. There is no production or return, and hence profit is: $\pi_0 = -I$. In period 1, the investment, I, starts yielding return, and hence accounting profit is: $\pi_1 = [(1+\theta)(p+\delta)]I$, where θ is inflation and p is real economic return net of economic depreciation δ. In period 2, $(1-\delta) \times I$ comprises the input that yields return, resulting in $\pi_2 = (1+\theta)^2(p+\delta)(1-\delta)$; and so on. The investment lasts until the asset is economically obsolete. The net present value of this investment (NPV) is given by:

$$\sum_{t=0}^{\infty} \frac{\pi_t}{(1+i)^t} = -I + \sum_{t=1}^{\infty} \frac{(1+\theta)^t(p+\delta) \times (1-\delta)^{t-1} I}{(1+i)^t} = \frac{(p-r)I}{r+\delta}, \tag{1}$$

becomes even larger than zero. We discuss this issue in detail in Section 4.

[17] Loosely speaking, if an investment of 100 is made and the tax depreciation is a straight line, say 20 percent annually, the ACE in the first period will be for an equity level of 80 (not 100), and 60 for the second period (not 80 plus inflation), and so on. Otherwise, the ACE is not anymore a neutral system with respect to inflation and deprecation as it should be in theory.

[18] The Appendix presents a step-by-step derivation of all results. The model builds on various contributions to the literature including Devereux and Griffith (1998), Devereux and Griffith (2003), and Klemm (2008).

where i is the nominal interest rate and r is the real interest rate.[19] If $p = r$, economic rent is zero (it is a marginal investment). If $p > r$, the investment yields economic rent. The sum of the economic depreciation and the real economic return net of economic depreciation, $(p + \delta)$, equals the real return before depreciation, interest expense, and tax (EBIDTA).

Next, consider a standard CIT. Let the tax depreciation function be denoted by φ; for example, a straight-line depreciation over five years means that $\varphi = 20$ percent annually.[20] In period 0, the taxable profit is a loss that is equivalent to the capital depreciation for tax purposes, given by the function φ, that is, $\pi_0^T = -\varphi(I)$. Taxable profit in period t, for an equity-financed investment, before adjusting for loss carry forward from previous periods, is: $\pi_t = (1+\theta)^t(p+\delta) \times (1-\delta)^{t-1}I - \varphi(K_t)$, $\forall\, t > 0$, where the tax depreciated asset K_t is as follows: $K_0 = I$, $K_1 = I - \varphi(I), K_2 = I - \varphi(I) - \varphi\left(I - \varphi(I)\right)$, and so on.

For comparability and as a theoretical benchmark, the working assumption throughout this paper is that the tax value of losses is refundable or equivalently carried forward with interest (unless mentioned otherwise). Let τ be the statutory CIT rate and the investment be fully financed via equity. The amount of the tax in each period is:

$$T_0 = -\tau\varphi(I), \tag{2}$$

$$T_t = \tau(1+\theta)^t(p+\delta) \times (1-\delta)^{t-1}I - \tau\varphi(K_t) \qquad \forall\, t > 0. \tag{3}$$

The net present value of the total tax amount, T (without the time index t), over the lifetime of the investment is:

$$T = -\tau A + \frac{\tau(p+\delta)}{r+\delta}I, \tag{4}$$

where $A \equiv \sum_{t=0}^{\infty} \frac{\varphi(K_t)}{(1+i)^t}$, and for convenience later: $\frac{A}{I} \equiv \tilde{A}$.

The AETR is the net present value of the tax (given in Equation 4), normalized by the net present value of the pre-tax total income stream, net of depreciation:

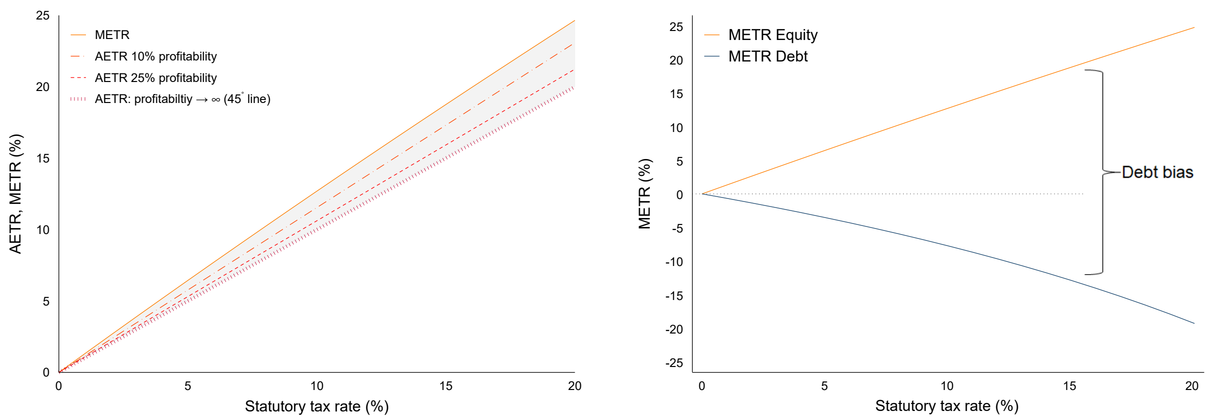
$$AETR = \frac{T}{\frac{p}{r+\delta}I} = \tau\left[1 + \frac{\delta - \tilde{A}[r+\delta]}{p}\right]. \tag{5}$$

The AETR increases (i) as τ increases (given a profitability); or (ii) as profitability declines (given τ). For high levels of profitability (that is, as $p \to \infty$ and the term $\frac{\delta - \tilde{A}[r+\delta]}{p}$ becomes zero), the AETR

[19] Note that $(1+i) = (1+\theta)(1+r)$.

[20] Tax depreciation is assumed to be the same as accounting depreciation.

Figure 1: *AETRs and METRs without a Minimum Tax*



(a) *Equity-Funded Investment* **(b)** *Debt Bias*

Note: METR stands for the marginal effective tax rate, computed for the marginal investment that just breaks even. AETR stands for the average effective tax rate. The figure assumes an inflation rate of 5%, a real interest rate of 5%, an economic depreciation rate of 25%, a depreciation rate for tax purposes of 25%, and a full loss offset. The left panel assumes full equity financing and shows that the AETR and the METR are increasing in the statutory rate (given profitability). The AETR converges to the statutory tax rate as profitability increases (given a statutory rate). This convergences is depicted in the shaded region and through vertically moving from the AETR lines corresponding to 10% and 25%, profitability. In the limit (as profitability $\to \infty$), the AETR approaches the 45° line. The right panel visualizes the debt bias. The METR for a fully debt-financed investment (blue line) is negative (i.e., a subsidy).

converges toward the statutory tax rate τ, as shown in the left panel of Figure 1. The shaded area demonstrates that the AETR line tilts down as profitability increases (given τ) reaching the limit when fully coinciding with the 45° line at extremely high profitability (in other words, it approaches τ).

Higher depreciation allowances lower the AETR (by raising the term A), in line with empirical evidence that finds that accelerated depreciation is effective in accelerating investment, including for example Zwick and Mahon (2017) for the US and Maffini et al. (2019) for the UK. Note that given an investment profile, the AETR can be higher than τ depending on depreciation and inflation. In particular, as it can readily be seen from Equation 5, high inflation or less generous tax depreciation increases the AETR by lowering A. The AETR is important for the discrete location choice for new investments by multinationals that tend to generate high profitability from proprietary assets (Devereux and Griffith, 1998). It is often used in customary international tax ranking databases such as Oxford CBT (2017) and OECD (2023).

Investment Distortion

The METR corresponds to the case of no economic rent (that is, defined for the marginal investment). To derive the METR, we need to retrieve the post-tax value of p that makes the post-tax economic rent of the investment ($\tilde{p}$) zero, by setting the difference between Equations 4 and 1 to zero and solving for $\tilde{p}$. This $\tilde{p}$ is also known as the user cost of capital. The METR is then given by:

$$METR = \frac{\tilde{p} - r}{\tilde{p}}, \tag{6}$$

where $\tilde{p} = \frac{1}{1-\tau}(r + \delta - \tau\tilde{A}(r + \delta)) - \delta$. Without a tax, the marginal investment yields $p = r$. If the METR = 0, at the margin, the investment that just breaks even is still viable in the presence of the tax, and in this sense the tax system is efficient. If the METR > 0, there is a tax wedge between pretax and post-tax return, making this investment at the margin unprofitable due to the tax. Under the CIT, an equity-financed investment faces a positive METR that linearly increases in τ (Figure 1). If the METR < 0, the investment, at the margin, is subsidized.

Debt Bias

The source of the financing of the investment is one important determinant of the METR and AETR under a standard CIT. Debt-financed investments benefit from deducting interest expenses and therefore are associated with lower AETRs than fully equity-financed investments that receive no deductions on their returns. For debt-financed investments, the NPV of taxes and the corresponding AETR (in Equation 5) should be modified to allow for interest deductions. Given some degree of debt financing ($0 \leq \alpha \leq 1$), the AETR becomes:

$$AETR = \underbrace{\tau\left[1 + \frac{\delta - \tilde{A}[r + \delta]}{p}\right]}_{AETR \text{ for full equity-financing}} - \underbrace{\frac{\tau\alpha i}{p(1+\theta)}}_{\text{debt bias}}, \tag{7}$$

Decreasing interest deductions (through lowering the share of debt α) raises the AETR. The tax benefit from debt-financing increases in τ. If $\alpha = 0$ then Equation 7 collapses to 5.

Precisely, there are two elements of debt bias. First, debt receives interest deductions (the presence of the additional term $-\frac{\tau\alpha i}{p(1+\theta)}$ in Equation 7). Second, the amount of interest deduction in this new term is not tied to the normal return and can well exceed it.[21] The METR for the

[21] In the standard CIT system, the typical deduction for debt in each period is denoted as $i((1+\theta)(1-\delta))^{t-1}\,\forall t \geq 1$, while the deduction to account for normal return is expressed as $i(1-\varphi)^t\,\forall t \geq 1$. The latter leads to a zero METR for

fully debt-financed investment is even negative due excessive interest deductions beyond the normal return (right panel of Figure 1). The extent of this negative METR depends on inflation, depreciation, and tax rate. Higher inflation, higher depreciation, and higher tax rates increase the debt bias. The welfare implications of the debt bias has been studied in various papers, ultimately calling for a system that eliminates the tax-favored debt treatment (to name a few: IMF, 2016; Mirrlees Review, 2011; Sørensen, 2017; and Weichenrieder and Klautke, 2008).

One way to eliminate the debt bias is the Comprehensive Business Income Tax (CBIT) that was proposed by Department of the Treasury (1992). The CBIT treats debt as equity, by denying interest deductions and exempting interest income. Hence, Equation 5 also gives the AETR on debt-funded investment under the CBIT, thereby neutralizing the debt bias (compared to Equation 7). However, the CBIT leaves the investment distortion unaddressed (as the METR remains greater than zero as in Equation 6). The two efficient rent tax systems that address both investment distortion and debt bias are cash-flow taxation or the ACE. Next, we examine how the minimum tax affects the METRs an AETRs under the CIT.

2.2 Introducing a Minimum Tax to a Standard CIT

The minimum tax under Pillar Two is determined in the following sequence. First, in each year, the top-up tax rate (τ_t^{topup}) is computed as the difference between 15 percent and the ratio of covered domestic taxes ($T_t^c = \tau\pi_t^c$) to covered income ($\pi_t^c = \pi_t - loss\,refunds_{t-1}$), where π_t^c includes loss carryforward from previous periods.[22] We will see later that under the ACE or cash-flow taxation, generally, the difference between π_t^c and π_t goes beyond loss refunds. For the CIT, thus,

$$\tau_t^{topup} = \max\left(0, \left(15\% - \frac{T_t^c}{\pi_t^c}\right)\right) = \max\left(0, \left(15\% - \frac{\tau\pi_t^c}{\pi_t^c}\right)\right) = \max\left(0, (15\% - \tau)\right), \tag{8}$$

Second, in an year t, if the top-up tax rate (τ_t^{topup}) is greater than zero, a top-tax is applied to the covered profit in excess of the SBIE in t, set at 5 percent of tangible assets and payroll, after a transition period. Thus, the top-up base in t is $\max(0, \pi_t^c - SBIE_t)$, where the term 'max' explicitly accounts for the fact that if $SBIE_t > \pi_t^c$ in some t there will be no carryover.[23] If τ_t^{topup} is zero, the minimum tax is not binding, irrespective of the SBIE. Hence, in any t, the total tax (T_t) including

all inflation and depreciation levels. On the other hand, the AETR and METR under the standard debt deduction are dependent on inflation and the depreciation rate.

[22] Generally, the 15% can be replaced by a parameter $0 < a < 1$.

[23] If alternatively, the top-up base is expressed as $\pi_t^c - SBIE_t$, then analysis would be based on the strong assumption that the firm can carryforward any 'excess SBIE' to future periods to lower future top-up bases.

the top-up tax, is given by:

$$T_t^{Pillar2} = \tau\pi_t + \left[\max\left(0, (15\% - \tau)\right) \times \max(0, \pi_t^c - SBIE_t)\right], \ \forall\ t \geq 0. \tag{9}$$

If, in year t, for example, $\tau = 0$, π^c is 100, and the SBIE is 20, then the covered tax is zero, the top-up rate (τ^{topup}) is 15 percent, and the resulting top-up tax is 12 (that is, $15\% \times (\pi^c - SBIE)$). This means, the average tax rate is 12 percent while Pillar Two effective rate on profit exceeding the SBIE (after the top-up) becomes 15 percent. If the covered tax is 5, then the top-up rate is 10 percent, the top-up tax is 8, and the total tax paid is 13.

Under Pillar Two, for the calculation of the effective tax rate on investment in a host country (where the investment actually takes place), it is irrelevant for investment whether the host country or the headquarter country applies the top-up tax. The reason is that the in-scope multinational investor should pay the top-up tax anyway; that is, the host country cannot lower its effective tax rate by ceding the revenue from the top-up tax to other countries. Pillar Two allows the host country to collect the top-up revenue (if it adopts a specific rule called 'qualified domestic top-up tax' rule), or else headquarter countries would collect the top-up tax (via the 'income inclusion rule').[24]

Two aspects are worthwhile stressing when thinking about how a minimum tax affects investment. First, the minimum tax test is applied on a yearly basis, rather than at the end of the investment; that is, conceptually, even if the pre-minimum tax exceeds 15 percent in NPV terms taking the investment as a whole, a top-up tax can still be applied in some years. The NPV of the tax, thus, considers any yearly top-up taxes that are paid over the lifetime of the investment. Second, if $\tau_t^{topup} > 0$, then the top-up tax amount in any t is a function of the SBIE. Conceptually, the investment-specific SBIE is time-varying due to depreciation of tangible assets throughout the investment duration. Thus, the SBIE is independent of the mode of financing (debt of finance), but depends on the nature of the asset (tangibles versus intangibles). For the derivation of the expressions of the effective tax rates, we do not make any assumptions on the SBIE. From the standpoint of the investor, these equations give a menu of AETRs for different values of SBIE. There can be different values of the SBIE that are consistent with the same project. First, to the extent that the production technology of the investment enables substitution between tangibles,

[24] The current U.S. minimum tax design, known as 'Global Intangible Low-Taxed Income (GILTI)', is somewhat an exception as it is not imposed on a country-by-country basis. This worldwide 'blending' approach makes the investment location choice not a discrete one. It is not yet clear whether the GILTI will be recognized as an IIR without being converted to a country-by-country design.

intangibles, and labor, the value of SBIT can be optimised to lower the tax (since the SBIE considers only tangibles and labor). Second, beyond the project itself, the values of the assets and payrolls of other projects (or firms that belong to the group) increase the SBIE.

Losses can be carried forward indefinitely under Pillar Two rules as a deduction in the computation of π_t^c. In our baseline analysis we maintain the full loss offset, and assume that any tax loss refunds or interest on the loss carryforward do not affect the Pillar Two effective rate. We relax the full loss offset assumption in Section 5. Pillar Two rules do not stipulate how to deal with a full loss offset (see discussions in Section 5).

The NPV of the tax under Pillar Two (and full loss offset) for equity financed investment has an added term to the NPV under a standard CIT:

$$T^{Pillar2} = T^{No\,minimum} + \sum_{t=1}^{\infty} \max(0, (15\% - \tau)) \frac{\max\left(0, (\pi_t^c - SBIE_t)\right)}{(1+i)^t}, \tag{10}$$

where $T^{No\,minimum}$ is the net present value of the total tax amount without a minimum tax. The first two terms in Equation 10 are the same as in Equation 4 for the standard CIT. The third term in Equation 10 is zero as long as there is no top-up tax, otherwise it is strictly positive. The resulting AETR is:

$$AETR^{Pillar2} = AETR^{No\,minimum} + \frac{\sum_{t=1}^{\infty} \max(0, (15\% - \tau)) \frac{\max(0, (\pi_t^c - SBIE_t))}{(1+i)^t}}{\frac{p}{r+\delta}}, \tag{11}$$

where $AETR^{No\,minimum}$ is the AETR in the absence of a minimum tax as in Equation 7. $AETR^{Pillar2}$ used to compute $METR^{Pillar2}$ in the same way as in Equation 6.

Thus, the minimum tax raises the METR and AETR in the top-up region (left panel of Figure 2). Both the METR and AETR under Pillar Two have kinks, determined by the cutoff $\tau = 15\%$. Above this cutoff, the minimum tax is not binding and both the ETR and AETR become identical to those in Figure 1.[25] Moreover, the minimum tax sustains the debt bias (right panel of Figure 2).

The AETR or METR in the top-up region are also determined by the size of the SBIE in the years of the application of the top-up tax. The AETR is the highest (approaching 15%) if the investment fully relies on intangible assets and zero payrolls (generally low SBIE) and it is the lowest if the investment is heavily dependent on tangibles and high payrolls (high SBIE). Thus, theoretically,

[25] The left panel of Figure 2 reveals an intriguing quirk resulting from the minimum tax. Namely, at a very low τ, around 5% in the chart, the AETR becomes higher the higher the profitability. The reason is that the SBIE deduction becomes less valuable in early years while the top-up tax amount is the highest.

for some investments, the top-up amount can be zero, eliminating the kink in the AETR function, even for $\tau < 15\%$ if the SBIE is sufficiently large. Note, if there is no top-up tax at all, Equation 11 collapses to Equation 5 reflecting a standard CIT. In the top-up region, where ($\tau < 15\%$), the minimum tax generally raises the METR (compared to a standard CIT), because it falls on normal return of an equity-financed investment. For $\tau >= 15\%$, the METR is unaffected, identical to that in Figure 1. The following propositions summarize the key results:

Proposition 1. *Under a standard CIT and a minimum tax and a full loss offset:*

(a) If $\tau < 15\%$, there is a top-up tax at least in one year, t, during the investment if $\pi_t^c - SBIE_t > 0$. The rustling METR and AETR are higher than under the standard CIT without a minimum tax.

(b) If $\tau \geq 15\%$, the minimum tax has no implications.

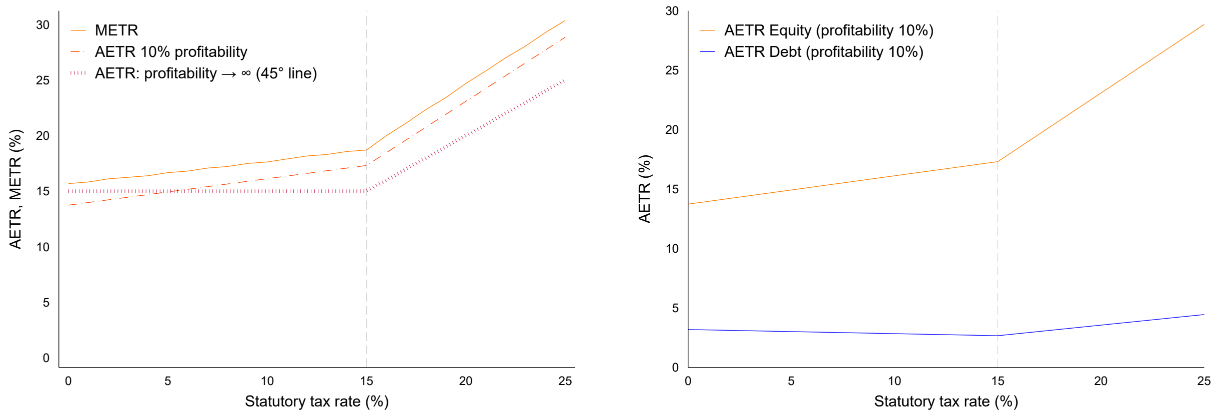
Proof. See Appendix. □

Proposition 2. *If $\tau_t^{topup} > 0 \, \forall t$, even if the SBIE is equal to the normal return in NPV term $\left(\sum_{t=1}^{\infty} \frac{SBIE_t}{(1+i)^t} = \frac{r}{r+\delta}\right)$, the top-up tax amount is strictly positive.*

Proof. See Appendix. □

The policy-relevant question that arises: what tax base provisions or tax system designs can lower the METR (ideally to zero to eliminate investment distortion) without triggering a minimum tax that falls on normal return? This question is the focus of the rest of the paper, by first looking at tax base provisions under a standard CIT and next analyzing how efficient rent tax designs are affected by the minimum tax.

Figure 2: *AETRs under a CIT and a Minimum Tax*



(a) *Standard CIT and a Minimum Tax* **(b)** *Introducing Non-refundability and Borrowing; p =10%*

Note: METR stands for the marginal effective tax rate, computed for the marginal investment that just breaks even (post-tax). AETR stands for the average effective tax rate. The figure assumes full equity financing, an inflation rate of 5%, a real interest rate of 5%, an economic depreciation rate of 25%, a depreciation rate for tax purposes of of 25%, and a full loss offset. The figure assumes that the assets are entirely tangibles (i.e, the lowest possible top-up tax, given payrolls), and payrolls comprise 50 percent of tangibles (the average for U.S. multinationals taken from the Bureau of Economic analysis). This means that the calibration sets the SBIE at 150% of tangibles. The analysis takes into account that the SBIE cannot be carried forward. As profitability increases (given a statutory rate), the AETR converges to the statutory tax rate (the 45° line outside of the top-up region and to the minimum rate, 15%, in the top-up region (horizontal line). The right panel visualizes the debt bias that persists under the minimum tax.

2.3 Tax Incentives under a Standard CIT and a Minimum Tax

Pillar Two rules distinguish between two types of domestic tax credits. The first is refundable tax credits paid as cash (or equivalents) within four years, referred to as 'qualified refundable tax credits (QRTCs)'. QRTCs increase the covered income by the full amount of the credit; that is, QRTCs increase the denominator in the Pillar Two effective rate causing it to decline (Table 1). And it raises the top-up tax base by the mount of the credit. The second type of credits includes any other tax credits, which are then deemed as non-qualified refundable tax credits (NQRTCs) that reduce the covered tax (that is, NQRTCs decrease the numerator in Pillar Two effective rate). A NQRTC lowers the Pillar Two effective rate by more than a QRTC (of the same amount) does, and hence gives a higher τ^{topup} (Table 1). NQRTCs do not change the top-up tax base.

Let X denote the amount of the tax credit so that the tax amount without a minimum is $(\tau\pi_t^c) - X_t$. Considering the minimum tax, the average tax payment in period t for the QRTCs and

Table 1: *Top-up Rate and Base with Tax Credits*

	No Credits	QRTC	NQRTC
Top-up rate	$15\% - \frac{\tau\pi_t^c}{\pi^c}$	$15\% - \frac{\tau\pi_t^c}{\pi^c+X_t}$	$15\% - \frac{\tau\pi_t^c - X_t}{\pi_t^c}$
Top-up base	$\pi_t^c - SBIE_t$	$\pi_t^c + X_t - SBIE_t$	$\pi_t^c - SBIE_t$

Note: (N)QRTC stands for a (Non)Qualified Refundable Tax credit. X is the amount of the tax credit. $SBIE$ is substance-based income exclusion.

NQRTCs, respectively, is:

$$ATR_t^Q = \tau - \frac{X_t}{\pi_t^c} + \max\left(0, \left(15\% - \frac{\tau\pi_t^c}{\pi^c + X_t}\right)\right) \max\left(0, 1 + \frac{X_t}{\pi_t^c} - \frac{SBIE_t}{\pi_t^c}\right), \tag{12}$$

$$ATR_t^{NQ} = \tau - \frac{X_t}{\pi_t^c} + \max\left(0, \left(15\% - \tau - \frac{X_t}{\pi_t^c}\right)\right) \max\left(0, 1 - \frac{SBIE_t}{\pi_t^c}\right). \tag{13}$$

Following the logic of deriving Equation 5 and using Equations 12 and 13, we obtain quite lengthy expressions for the AETRs (documented in the Appendix). The key lessons from the effective rates with tax credits are summarized in Proposition 3.

Proposition 3. *Under a standard CIT, full loss offset, and a binding minimum tax,*

(a) Both QRTCs and NQRTCs increase the top-up tax by less than the value of the credit. Hence, the total tax is lower with either QRTCs or NQRTCs than under a CIT without tax credits.

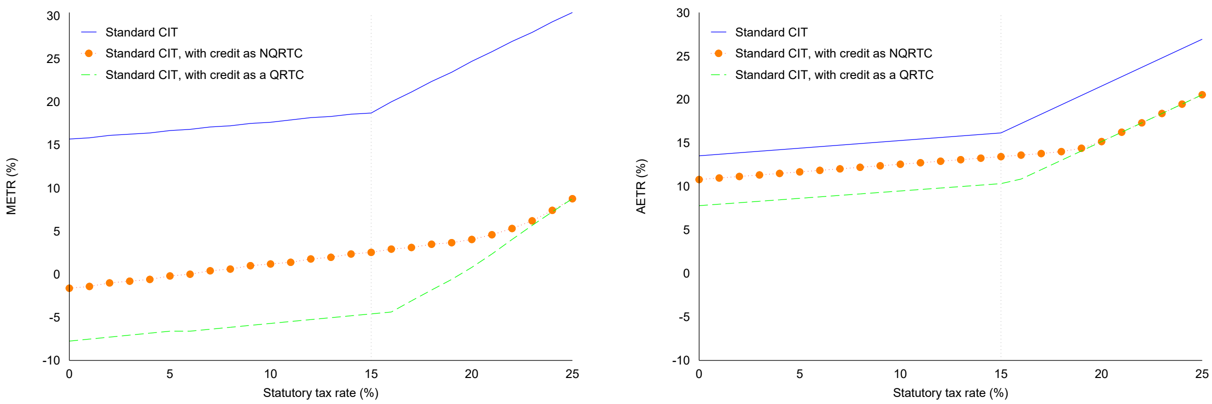
(b) The QRTC implies a lower AETR than the NQRTC if the SBIE is low, and vice versa. The NQRTC leads to a lower AETR than the QRTC as $SBIE \to \pi^c$.

Proof. See Appendix. □

Intuitively, regarding part (b) of Proposition 3, if $SBIE = \pi^c$ then the top-up tax base ($\pi_t^c - SBIE_t$) is zero for any value of a NQRTC (Table 1). In contrast, under a QRTC, there will be a top-up tax, the base of which is the credit itself ($\pi_t^c + X_t - SBIE_t = X_t$). However, despite this tax on that credit, the investment ends up with a lower total tax because for each dollar of refunded cash, only a portion is taxed.

To get a sense of the magnitudes, Figure 3 plots the METRs and AETRs for a fully equity-financed investment in the presence of a minimum tax and the different types of tax credits. The two main messages are: (i) a negative METR (that is, a subsidy) is possible even under a minimum tax through a QRTC; and (ii) the METR and AETR tend to be lower under the QRTCs than NQRTCs, but converge as τ increases (given a size of the tax credit). The reason behind the latter is that the application of the minimum tax is prevented at some high τ. This cutoff τ is higher for NQRTCs.

Figure 3: *Tax Credits under a Minimum Tax*



(a) *Standard CIT and a Minimum Tax* **(b)** *Introducing Non-refundability and Borrowing; p =10%*

Note: METR stands for the marginal effective tax rate, computed for the marginal investment that just breaks even (post-tax). AETR stands for the average effective tax rate. The figure assumes full equity financing, an inflation rate of 5%, a real interest rate of 5%, an economic depreciation rate of 25%, a depreciation rate for tax purposes of of 25%, and a full loss offset. The figure assumes that the assets are entirely tangibles (i.e, the lowest possible top-up tax, given payrolls), and payrolls comprise 50 percent of tangibles (the average for U.S. multinationals taken from the Bureau of Economic analysis). This means that the calibration sets the SBIE at 150% of tangibles. The analysis takes into account that the SBIE cannot be carried forward. (N)QRTCs are (non)qualified refundable tax credits that affect the top-up rate and base as in Table 1. The size of the credit is assumed to be 10 percent of the value of the investment in net present value term.

3 Cash-Flow Tax

3.1 No Minimum Tax

The tax base for the R-based cash-flow tax comprises net real transactions ('R-based'), meaning it includes only real (non-financial) cash flows. This system eliminates the tax deductibility of interest payments and the corresponding taxation of interest income received by lenders, such as banks. Gross inflows are represented by sales, including sales of capital goods. Gross outflows cover all expenses including labor costs, and purchases of intermediate and capital goods. Financial transactions like interest payments, variations in net debt, and dividend distributions are excluded from the tax base. In cases of losses, the system allows for immediate tax refunds or the option to carry these losses forward, applying an appropriate interest rate. The R-based cash-flow tax is thus not identical to a CIT providing immediate expensing (which would be combining a 100 depreciation upfront with interest deductions), as we will discuss below.

The other forms of cash-flow taxes are the R+F-based cash-flow tax (where the tax base includes net real transactions and net financial transactions) and the S-based cash-flow tax (where the base is net distributions of companies to shareholders). We show in the Appendix (along the lines in Meade Committee, 1978) that these are equivalent to the R-based cash-flow tax, and proceed here with the R-based form.

The NPV of the total tax paid under the R-based cash-flow tax is:

$$\begin{aligned} T^{R-based} &= -\tau I + \sum_{t=1}^{\infty} \tau \frac{(1+\theta)^t (p+\delta) \times (1-\delta)^{t-1} I}{(1+i)^t} \\ &= \underbrace{-\tau A + \frac{\tau(p+\delta)}{r+\delta} I}_{\text{standard CIT}} \quad \underbrace{-\tau I + \tau A}_{\text{time value of immediate expensing}} \\ &= \frac{\tau(p-r)}{r+\delta} I. \end{aligned} \tag{14}$$

Equation 14 can be decomposed into two components:

1. The first component, $-\tau A + \frac{\tau(p+\delta)}{r+\delta} I$, is the net present value of the standard CIT payment overtime.

2. The second component, $-\tau I + \tau A = \tau(A - I)$, represents the reduction in the net present value of the tax due to immediate expensing (compared to a standard CIT). *Higher* tax rates ($\uparrow \tau$), *higher* discount rate ($\downarrow A$), or *lower* standard depreciation rate ($\downarrow A$)) increases the benefit of immediate expensing.

Dividing Equation 14 by the net present value of the return, gives the AETR under a cash-flow tax:

$$AETR^{R-based} = \frac{\frac{\tau(p-r)}{r+\delta} I}{\frac{p}{r+\delta} I} = \tau(1 - \frac{r}{p}). \tag{15}$$

As under a standard CIT, the AETR gradually converges to the statutory tax rate τ as economic rent increases ($\uparrow p$), since then the ratio r/p approaches zero. The left panel of Figure 4 visualizes this convergence toward the 45° line as profitability increases (given τ. For instance, the AETR for an investment with profitability of 20 percent is always higher than that with a profitability of 10 percent. However, the AETR for a fully equity-funded investment under the cash-flow tax remains lower than under a standard CIT (the left panel of Figure 1 versus that in 4).

Eliminating Investment Distortions

The pre-tax economic rent is $\frac{p-r}{r+\delta}$ whereas the post-tax economic rent of a project in a cash-flow tax system as $(1-\tau)\frac{(p-r)}{r+\delta}$. Solving for the user cost of capital that sets the post-tax economic rent to zero gives $\tilde{p}=r$.

If profit equals the normal return $r=p$, Equation 15 collapses to zero for any τ and, hence, the METR is zero for all τ (recalling that the METR corresponds to the AETR of a project that yields economic return equal to the cost of capital). This result makes the cash-flow tax efficient: it does not affect the decision to undertake the marginal investment (since post-tax return is equal to pretax return).[26] On the contrary, for a standard CIT, for example with the parameterization in Figure 1 at $\tau = 15$ percent, the METR on a fully-equity funded marginal investment reaches 20 percent (compared to zero under a cash-flow tax).

Eliminating Debt Bias

The R-based cash-flow tax does not allow interest deductions, as reflected in Equation 15 that does not contain an analogous term to $-\frac{\tau\alpha i}{p(1+\theta)}$ in Equation 7. The system is, therefore, independent of the mode of financing (debt or equity), and R-based cash-flow tax eliminates the debt bias of the standard CIT system. It is also not affected by the depreciation function since it does not include the term A.

3.2 A Minimum Tax with an R-based Cash-Flow System

The mechanics of the minimum tax are the same as above as Pillar Two effective rate is unaffected by immediate expensing. But, here, $\pi_t^c = \pi_t - net\ interest\ deduction - loss\ refunds$. This means Pillar Two reintroduces debt bias because the top-up rate and base depend on the financing. For debt financing, the top-up rate becomes smaller: $\tau_t^{topup} = 15\% - \frac{\tau(\pi_t^c + net\ interest\ deduction)}{\pi_t^c}$. The top-up base is also smaller for debt-financed investments due to allowing interest deductions.

The NPV of the tax on equity-financed investment, is an augmented Equation 15 as follows:

$$T^{R-based,Pillar2} = \tau\frac{(p-r)}{r+\delta}I + \max(0, 15\% - \tau)\sum_{t=1}^{\infty}\frac{\max\left(0, (\pi_t^c - SBIE_t)\right)}{(1+i)^t}. \tag{16}$$

[26] Sandmo (1979) proves that τ needs to be constant to ensure the neutrality of the cash-flow tax, although future changes in τ remain consistent with investment neutrality if the weighted average of those future changes is equal to the initial τ.

The AETR becomes:

$$AETR^{R-based,\,Pillar2} = \tau(1 - \frac{r}{p}) + \frac{\max(0, 15\% - \tau) \sum_{t=1}^{\infty} \frac{\max(0,\,(\pi_t^c - SBIE_t))}{(1+i)^t}}{p/(r+\delta)}. \tag{17}$$

From Equation 17, it can be readily seen that if $\tau > 15\%$, the METR remains zero as no top-up tax applies. However, if $\tau < 15\%$, the top-up tax is applied on normal return, resulting in $METR > 0$. Proposition 4 summarizes the implications of Pillar Two under an R-based cash-flow tax.

Proposition 4. *Under a minimum tax and a full loss offset that is regraded as a timing measure for the top-up tax:*

(a) If $\pi_t^c - SBIE_t \leq 0\ \forall t$, no top-up tax applies and the R-based cash-flow tax system retains its efficiency (METR = 0)

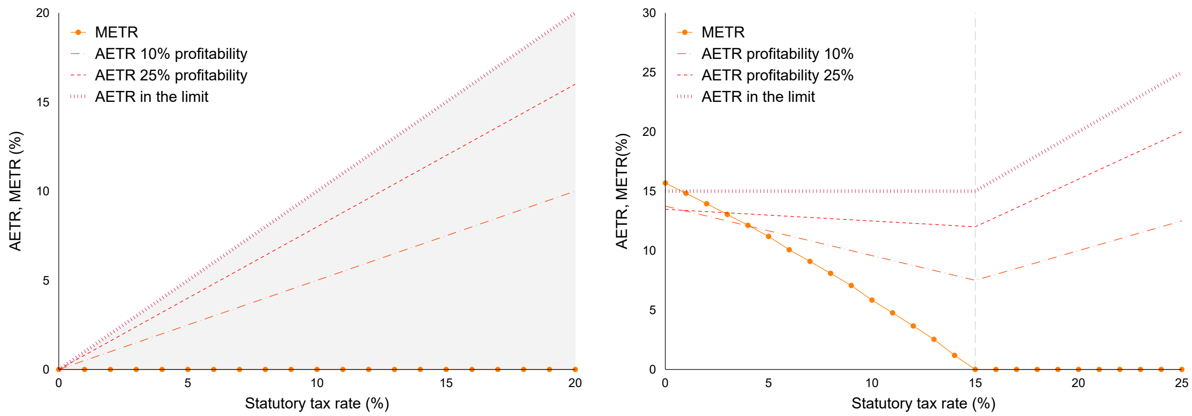
(b) If $\pi_t^c - SBIE_t > 0$ for at least one t:

- *If $\tau < 15\%$:*
  - *For an equity-funded investment: the R-based cash-flow tax is no longer efficient and the METR > 0. The resulting AETR is higher than in the absence of a minimum tax.*
  - *For a debt-funded investment: the R-based cash-flow tax remains efficient with a METR = 0 even in the top-up region. The resulting AETR is the same as in the absence of a minimum tax.*
- *$\tau \geq 15\%$, the R-based cash-flow tax retains its efficiency for any investment (METR = 0), and the AETRs in the R-based cash-flow tax with or without a minimum tax are identical.*

Proof. See Appendix. □

Part (b) of Proposition 4 is a key result for guiding countries' responses to the minimum tax. Generally, the minimum tax generates a kink in the AETR for the R-based cash-flow system (Figure 4). From a policy standpoint, it might be a surprising outcome that the METR *increases* as the statutory tax rate τ decreases if there is a top-tax (as displayed in the right panel of Figure 4). This means that raising τ up to 15 percent is good for the marginal investment. The reason behind this result is that the top-up tax falls on normal return, which would not be taxed at all if $\tau > 15$ percent (or in the absence of a minimum tax altogether).

Figure 4: *METR and AETRs under Cash-Flow Taxes*



(a) *No Minimum Tax*

(b) *Minimum Tax*

Note: METR stands for the marginal effective tax rate, computed for the marginal investment that just breaks even (post-tax). AETR stands for the average effective tax rate. The figure plots the METR and AETRs udner an R-based cash-flow tax assuming full equity financing, an inflation rate of 5%, a real interest rate of 5%, an economic depreciation rate of 25%, a depreciation rate for tax purposes of of 25%, and a full loss offset. Panel b assumes that the assets are entirely tangibles (i.e, the lowest possible top-up tax, given payrolls), and payrolls comprise 50 percent of tangibles (the average for U.S. multinationals taken from the Bureau of Economic analysis). This means that the calibration sets the SBIE at 150% of tangibles. The analysis takes into account that the SBIE cannot be carried forward. As profitability increases (given a statutory rate), the AETR converges to the statutory tax rate (the 45° line outside of the top-up region and to the minimum rate, 15%, in the top-up region (horizontal line).

4 ACE

4.1 Without a Minimum Tax

The other class of efficient rent tax models achieves efficiency by providing allowances for normal returns. It can be in the form of an allowance of corporate capital, irrespective of the financing mode and instead of interest deductions (Boadway and Bruce, 1984). Or equivalently, and as implemented in a few countries, the design maintains interest deductions and tax depreciation while providing notional deductions for equity at the 'normal' return rate (i).[27]

The ACE is neutral with respect to the tax depreciation method under full loss offset (Keen and King, 2002). Higher depreciation in earlier periods is offset—in NPV terms—by lower future values of the assets and, hence, lower allowances. The ACE is also neutral with respect to inflation. The increase in the real tax amount (with high nominal profits due to inflation) is counterbalanced by an increase in the ACE.

[27] In practice, the allowance rate is linked to the yields on long-term government bonds, as for example in Belgium, Italy, and Türkiye (Hebous and Klemm, 2020; Hebous and Ruf, 2017).

To correctly evaluate an ACE regime, and establish that it is equivalent to cash-flow taxation before introducing a minimum tax, it is crucial to correctly specify the equity base for the tax allowance. Suppose the ACE is given to the non-depreciated value of equity in the first period, then it is not only that the base is inflated (given a higher allowance than the correct ACE) but also the allowance becomes non-neutral with respect to τ or depreciation. Such a specification error increases with inflation and τ. In our analysis, we calculate the allowance based on the *tax-depreciated* value of capital K_t, as it should be [28]:

$$\pi_0^T = -\varphi(I) \tag{18}$$

$$\pi_t^T = (1+\theta)^t(p+\delta) \times (1-\delta)^{t-1} I - \varphi(K_t) - \underbrace{i \times (K_t)}_{\text{ACE}} \qquad \forall t > 0, \tag{19}$$

where $K_0 = I$ and $K_1 = I - \varphi(I)$, $K_2 = I - \varphi(I) - (I - \varphi(I))$, and so on. This implies that the allowance in period 0 is zero. In period 1, the allowance is not for the entire investment I, but for what remains after depreciation. This issue is not a mere technicality, as failing to specify the ACE base can mislead the evaluation.

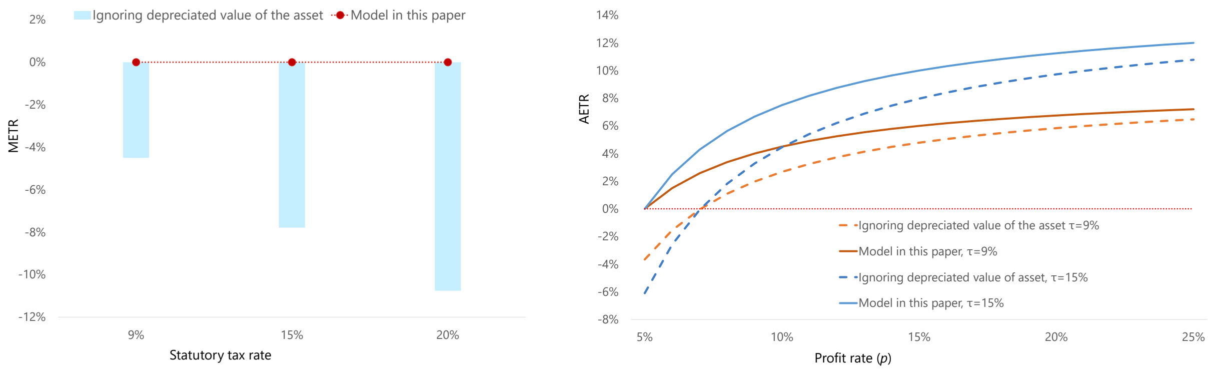
Figure 5 depicts the margin of error if the ACE is granted to the entire investment (as previously done in applied work). For the marginal investment (panel a in Figure 5), and $\tau = 15$ percent, the METR is underestimated by 8 percentage points. Figure 5 also shows that our model predicts a zero METR irrespective of τ. In panel b, we see that as the profitability increases the underestimation of the AETR declines; that is, the underestimation of the METR is more severe than that of the AETR at a high profitability. Moreover, in the Appendix, we show that the METR is neutral with respect to the choice of the depreciation function or inflation.

Proposition 5. *Under a full loss offset, in the absence of a minimum tax the ACE implies the same AETR as the R-based cash-flow tax (as given in Equations 14 and 15 and a zero METR.*

Proof. See Appendix. □

[28] If the project is financed with debt, the reduced equity would result in higher tax due to the reduction in allowance for equity. The increase in tax is equivalent to the decline in taxes from the debt deduction, thereby eliminating the debt bias. For instance, in period 1, $\pi_t^1 = (1+\theta)(p+\delta)I - \varphi(I - \varphi(I)) - \underbrace{i \times I}_{\text{interest on loan}} - (-\underbrace{i \times \varphi(I)}_{\text{ACE}}) = (1+\theta)(p+\delta)I - \varphi(I - \varphi(I)) - i \times (I - \varphi(I))$. This is equivalent to the taxable income of a project financed with retained earnings as shown in equation 19.

Figure 5: *METR and AETR under the ACE*



(a) *METR* **(b)** *AETR*

Note: METR stands for marginal effective tax rate. AETR stands for average effective tax rate. ACE stands for allowance for corporate equity. The figure assumes an inflation rate of 5%, a real interest rate of 5%, an economic depreciation rate of 25%, and a depreciation rate for tax purposes of of 25%. 'Hebous & Mengistu' refer to the model in this paper, which predicts a zero METR for the ACE (under any statutory tax rate), and increasing AETR in profitability and in the statutory tax rate. 'Literature' refers to the common pitfall of granting the ACE on the non-depreciated value of assets.

Eliminating Investment Distortions

Since the METR under the ACE is zero, the tax does not affect the marginal investment. The AETRs on economic rent under the ACE will be the same as under the R-based cash-flow tax with and without a minimum tax (and are, thus, depicted in the upper panels of Figure 4).

Eliminating Debt Bias

The ACE puts an end to tax-motivated financial structures because returns to equity receive similar deductions as interest expenses. Note that the ACE allows interest deduction of debt by an amount that is lower than that in the standard CIT. Precisely, the deduction for debt in each period under the standard CIT is $i\left[(1+\theta)(1-\delta)\right]^t \; \forall t \geq 0$. By contrast, the interest deduction under the ACE only accounts for normal return and it is expressed as: $i\,(1-\varphi)^t \; \forall t \geq 1$. While this neutrality feature depends on the discount rate, another condition under the ACE is that the allowance rate should be equal to normal rate of return (at which interest is deducted).

4.2 Introducing a Minimum Tax under an ACE

Any minimum tax is confronted with the question as how to treat the equity allowance. Under Pillar Two rules, there are two possibilities to classify the ACE: either QRTCs or NQRTCs (discussed in Subsection 2.3). If the ACE is a QRTC, the equity allowance is refunded, otherwise it is a NQRTC.

The ACE as a QRTC and a Minimum Tax

As a QRTC, the ACE raises covered profit, which lowers Pillar Two effective rate (by raising the denominator), and thus the top-up tax rate goes up, as given in: $\max(0, 15\% - \frac{\tau\pi_t^c}{\pi_t^c + (\tau i k_t)})$. The top-up tax base is $\pi_t^c + (\tau i k_t) - SBIE_t$. Two immediate observations: (i) the ACE top up base is larger than that for the R-based cash-flow tax since $(\pi_t^c + \tau i k_t - SBIE_t) > (\pi_t^c - SBIE_t)$; and (ii) the ACE top-up rate is always higher than the R-based top-up rate (Table 2).

Table 2: *Top-up Rate: ACE vs. R-Based Cash-Flow Tax*

	ACE NQRTC	vs	ACE QRTC	vs	R-Based
Equity	$15\% - \tau\frac{[\pi_t^c - i(k_t)]}{\pi_t^c}$	$>$	$15\% - \tau \underbrace{\frac{\pi_t^c}{\pi_t^c + (\tau i k_t)}}_{>0\,\&\,<1}$	$>$	$15\% - \tau$
Debt	$15\% - \frac{\tau[\pi_t^c + \textit{net interest deduction} - i(K_t)]}{\pi_t^c}$	$>$	$15\% - \frac{\tau[\pi_t^c + \textit{net interest deduction}]}{\pi_t^c + (\tau i k_t)}$	$>$	$15\% - \tau + \tau\frac{(\textit{net interest deduction})}{\pi_t^c}$

Note: "Equity" and "Debt" correspond to 100% equity- and 100% debt-financed investment, respectively. Interest deduction is $((1+\theta)(1-\delta))^{t-1}$.

Combining these modifications with Equation 14 (since the ACE yields an identical expression for the AETR without a minimum tax), the NPV of the tax and the corresponding AETR under a fully refundable ACE (as a QRTC) and a minimum tax, are, respectively:

$$T^{ACE+Pillar2} = \left\{\frac{\tau(p-r)}{1+r}I\right\} + \sum_{t=1}^{\infty} \max\left(0, 15\% - \left(\frac{\tau\pi_t}{\pi_t + \tau i K_t}\right)\right) \frac{\max\left(0, (\pi_t + \tau i K_t - SBIE_t)\right)}{(1+i)^t}. \tag{20}$$

$$AETR^{ACE+Pillar2} = \tau\left(1 - \frac{r}{p}\right) + \frac{\sum_{t=1}^{\infty} \max\left(0, 15\% - \left(\frac{\tau\pi_t}{\pi_t + \tau i K_t}\right)\right) \frac{\max(0,(\pi_t + \tau i K_t - SBIE_t))}{(1+i)^t}}{\frac{p}{r+\delta} I}. \tag{21}$$

The key insight (from comparing Equations 16 and 20) is that $T^{ACE+Pillar2} > T^{R-based+Pillar2}$ (given τ) as long as $\pi_t + \tau i K_t > SBIE_t$ in at least one t. The top-up tax makes the ACE loss its efficiency (panel a of Figure 6). Both the METR and the AETR are higher under the ACE with a top-up tax than under the cash-flow tax with the top-up (Figure 6). Without any top-up tax, the AETRs for both systems coincide and the METR remains zero.

The lower the depreciation the higher the effective rate of the ACE, thereby widening the difference between both systems. Also, under the top-up, the ACE is no longer neutral with respect to inflation; as inflation increases, $T^{ACE+Pillar2}$ goes up, and the ACE moves further away from the R-based tax.

Proposition 6. *Under a minimum tax, an ACE that is regarded as a QRTC, and a full loss offset that is regraded as a timing measure for the top-up tax:*

(a) The threshold $\tau^{ACE\,QRTC}$ *below which the top-up tax rate becomes strictly positive is given by:*

$$\tau_t^{ACE\,QRTC} = \frac{15\%\pi_t^c}{\pi_t^c - 15\%(iK_t)}.$$

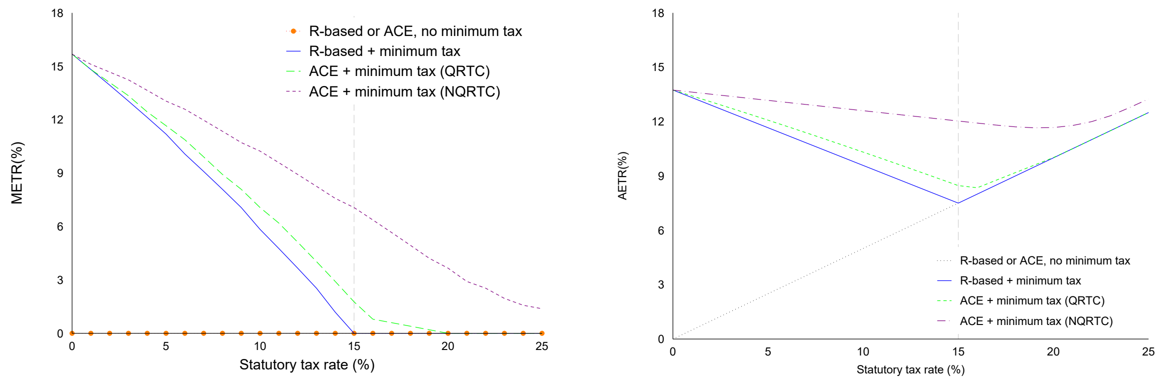
(b) If $[\pi_t^c + (\tau i K_t) - SBIE_t] \leq 0 \; \forall \; t$*, no top-up tax applies* $\forall \; \tau$*, and the METR under the ACE is zero.*

(c) If $[\pi_t^c + (\tau i K_t) - SBIE_t] > 0$ *and* $\tau < \tau_t^{ACEQRTC}$ *for any t, then there is a top-up tax and the METR > 0.*

(d) Under (c) above, the top-up tax amount and hence the METR are larger than under the R-based cash-flow tax, ceteris paribus.

Proof. See Appendix. □

Figure 6: *ACE vs. R-based Cash-flow Tax Under a Minimum Tax*



(a) *METR* **(b)** *AETR, p=10%*

Note: METR stands for marginal effective tax rate. AETR stands for average effective tax rate. ACE stands for allowance for corporate equity. The figure assumes full equity financing, an inflation rate of 5%, a real interest rate of 5%, an economic depreciation rate of 25%, a depreciation rate for tax purposes of 25%, and a full loss offset. The calibration sets the SBIE at 150% of tangibles, and the analysis takes into account that the SBIE cannot be carried forward. 'R-based or ACE, no minimum tax' depicts the METR and AETR before introducing a minimum tax, 'R-based + minimum tax' describes the METR and AETR of R-based cash-flow tax inclusive of the minimum tax. 'ACE minimum tax (QRTC)' depicts the AETR and METR of an ACE system inclusive of the minimum tax when the ACE is considered a QRTC, whereas 'ACE minimum tax (NQRTC)' plots the AETR and METR of an ACE system inclusive of the minimum tax if the ACE is considered a NQRTC.

The ACE as a NQRTC and a Minimum Tax

If the ACE is deemed as a NQRTC, then Pillar Two effective rate declines because of a decrease in covered taxes by the amount of the ACE (that is, lowering the numerator): $15\% - \frac{\tau\pi_t^c - \tau i K_t}{\pi_t^c}$, but the top-up base is not affected by this ACE: $\pi_t^c - SBIE_t$. The NPV of the total tax under the minimum tax need to be augmented to capture the the possibility of a top-up tax. The additional term for the AETR is $\frac{\sum_{t=1}^{\infty}\max\left(0{,}15\%-\tau(1-\frac{iK_t}{\pi_t^c})\right)\frac{\max(0,(\pi_t^c-SBIE_t))}{(1+i)^t}}{\frac{p}{r+\delta}I}$. Proposition 7 summarizes the key insights.

Proposition 7. *Under a minimum tax, full loss offset, and an ACE that is regarded as a NQRTC:*

(a) The threshold $\tau^{ACE\,NQRTC}$ below which the top-up tax rate becomes strictly positive is given by:

$$\tau^{ACE\,NQRTC} = \frac{15\%\pi_t^c}{\pi_t^c - ik_t},$$

and hence $\tau_t^{ACE\,NQRTC} \geq \tau_t^{ACE\,QRTC}\ \forall\ t$.

(b) If $[\pi_t^c - SBIE_t] \leq 0\ \forall\ t$, no top-up tax applies $\forall\ \tau$.

(c) If $[\pi_t^c - SBIE_t] > 0$ *and* $\tau < \tau_t^{ACE\,NQRTC}$ *for any* t*, then there is a top-up tax and the METR > 0.*

(d) The top-up tax amount if the ACE is QRTC cannot exceed that if it is NQRTC.

Proof. See Appendix. □

Comparing part (a) in Propositions 6 and 7 reveals that the threshold τ, needed to prevent the top-up tax, is lower when the ACE is classified as a QRTC rather than a NQRTC, but remains higher than 15%. This can be clearly seen in Figure 6. The resulting METR is significantly higher than a non-refunded ACE (QRTC) (Figure 6). This means countries can bring the ACE closer to the R-based cash-flow by making it refundable (to be considered as a QRTC), but it would remain inefficient and more distorting than the R-based cash-flow tax under a minimum tax. The AETR is also significantly if the ACE is a NQRTC. Part (b) in both propositions (6 and 7) indicates a situation of a very large SBIE that is sustained throughout the entire life of the investment. Note, however, that even if this condition holds, it does not make the ACE efficient as a system because it only maintains a zero METR for that particular investment but not for any investment (depending on the decomposition of tangibles, intangibles, and payroll). Comparing part (c) in Propositions 6 and 7, the higher top-up rate on the smaller base under the NQRTC ultimately overcompensates resulting in a higher top-up tax amount than under the QRTC ACE (unless $SBIE_t = \pi_t \; \forall \; t$; see Proposition 3).

5 The Role of Refunding the Value of Tax Losses

5.1 In the Absence of a Minimum Tax

Most CITs allow for carrying losses forward, but without interest. While the full loss offset assumption is an important theoretical benchmark and convenient to derive elegant formulas for the effective rates, relaxing it gives more realistic magnitudes especially if the purpose is to evaluate country-specific effective tax rates with (or without) minimum taxation.

In line with theory (Auerbach, 1986), when we relax full-refundability of tax losses, the NPV of the tax on investment increases. In our setting, we relax the full loss offset assumption by allowing indefinite loss carryforward but without interest (following the practice in several countries). As a consequence, if we assume, for example, that the loss carried forward is originated only in period 0, then there is an increase in T in Equation 4 by: $\frac{i}{1+i}\varphi(I)$ (see Appendix). The losses will be used in later periods, but without compensating for the time value of money. More generally, there is no closed form expression for the METR or AETR if losses are generated in multi-periods.

Following the derivation in the Appendix, we provide a routine for quantifying the AETRs and METRs allowing for multi-periods of loss carryforward. The Appendix presents charts depicting the AETRs and METRs without full loss offset in all systems examined in this paper.

The key insight here is that—given an investment profile and parameterization—the AETRs and METRs are always higher (and the NPV of tax depreciation is lower) without full loss offset, as depicted in the Appendix. Comparing countries' effective tax rates without considering the absence of loss offset can be a misleading exercise because the implications can be very different even under identical tax systems. Notably, high inflation exacerbates the impact of incomplete loss offset on effective tax rates. Under the same τ and depreciation, the higher the inflation the higher the METR/AETR if the value of tax losses is not refunded. The intuition is that the tax is imposed on nominal (rather than real) profit, while high inflation lowers the time-value of any amount that is carried forward without interest, ceteris paribus. This implies that inflation lowers post-tax returns, ceteris paribus.

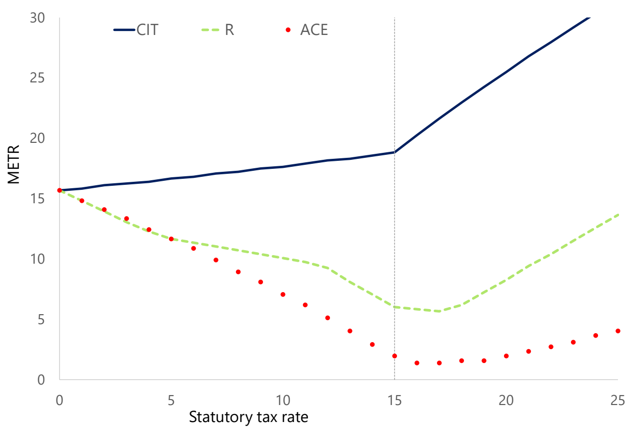
Another important aspect to note in the absence of full loss offset is that interest deductions (coupled with common depreciation schemes) make the METR zero. This means that the CIT becomes non-distorting for investment, albeit at the cost of distorting in the financial structure as it remains favoring corporate leverage. Note that in this system, the METR cannot be negative (unless there are other refundable tax credits). We will return to the issue of refunding tax losses in the discussion of efficient economic recent taxation.

5.2 The Tax Treatment of Loses Under Pillar Two

Pillar Two provides for the carryforward of losses indefinitely. However, it is unclear how Pillar Two will treat tax-loss refunds or interests on the loss carryforward. In the analysis, thus far, we assume that such a policy does not affect the Pillar Two effective rate (like a temporary timing measure). Another interpretation of our assumption is that the investment does not generate periods of losses (for example because of reinvesting in existing profitable projects), and hence it is irrelevant how Pillar two treats the full loss offset. Our assumption gives lower bounds for the METRs and AETRs since the Pillar Two effective rate is unaffected. If the tax loss refunds are treated as QRTCs then: (i) the equivalence between loss carryforward with interest and refunding tax losses breaks (as the former would then be NQRTCs); (ii) the Pillar Two effective rate declines and thus the METRs and AETRs become higher under a top-up tax than our baseline scenario; and (iii) the ACE generally yields lower METRs and AETRs than the R-based cash-flow tax (Figure

7). The reason for the latter outcome is that the ACE spreads the 'credits' over multiple years, thereby overall generating lower top-up taxes than the R-based cash-flow tax (which gives large credits—hence top-ups—in the initial periods). The upshot of this analysis is that Pillar Two warrants rules regarding such treatments of tax losses, ideally conducive to efficiency.

Figure 7: *METRs and AETRs If Tax Loss Refunds Are QRTCs*



(a) *METR* **(b)** *AETR; p =10%*

Note: METR stands for the marginal effective tax rate, computed for the marginal investment that just breaks even. AETR stands for the average effective tax rate. The figure assumes an inflation rate of 5%, a real interest rate of 5%, an economic depreciation rate of 25%, and a depreciation rate for tax purposes of 25%. The assets are entirely tangibles (i.e, the lowest possible top-up tax, given payrolls) and payrolls comprise 50 percent of tangibles (the average for US multinationals taken from the Bureau of Economic analysis). This means that the calibration sets the SBIE at 150% of tangibles. The analysis takes into account that the SBIE cannot be carried forward. Both panels assume that refunding the value of tax losses is considered as a qualified refundable tax credit (QRTC) under Pillar Two rules.

6 Putting It Together: Comparing the Effects of Different Tax Designs on Investment under a Minimum Tax

Before concluding, we put the pieces together in a snapshot of the MERTs under all systems. Consider an equity-funded investment (panel (a) of Figure 8). For any τ, the METR is the highest for the commonly existing CIT systems that do not refund the value of tax losses. Switching to immediate expensing (still without refunding losses) reduces the METRs by multiple percentage points. Under the R-based cash-flow tax, the METR is zero as long as the minimum tax does not result in a top-up tax. With a top-up tax (say at $\tau = 10$ percent), the R-based METR becomes strictly positive but remains the lowest among all other tax designs. The ACE outperforms the cash-flow tax if both systems do not allow refunding tax losses especially in the absence of a top-up tax.

Due to debt bias, for a fully debt-financed investment the picture is different (panel (b) of Figure 8). Despite the minimum tax, the METR in this case is negative under a CIT with full loss offset, driven by excessive deductions of interest payments. Further, interest deductions can compensate for denying refunding tax losses in the CIT, thereby eliminating investment distortion ($METR = 0$), but at the cost of encouraging corporate leverage. Since interest deductions are linked to the normal return, the ACE does not generate a negative METR even if tax losses are refunded.

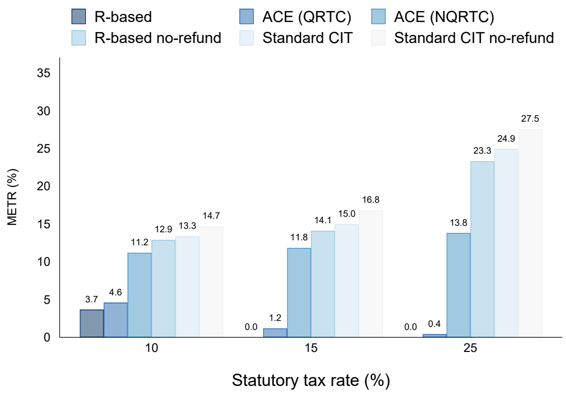
This analysis indicates how the top-up tax base can be modified to enhance efficiency. In particular, under a general efficient rent tax design, there are two equivalent ways to make the METR zero in the top-up region while being neutral with respect to financing decisions: (i) define the base of the top-up tax as "$EBIT_t - I_t$" while allowing carryover with interest (by "$\tau \times (EBIT_t - I_t)$" if $EBIT_t - I_t < 0$); or (ii) permit deductions for the normal return by modifying the top-up tax base to: "$\pi_t - (ik_{t-1})$", also while allowing for carryover with interest. In addition, both options require allowing the carry-forward of the value of tax losses with interest.

Note that even under minimum taxation, and common CITs that do not refund the value of tax losses, the METR can be negative (implying a subsidy for the investment) in spite of a top-up tax (panel (c) of Figure 8). This outcome is attainable in principle for any τ with a the appropriate QRTS. For a debt-financed investment, even a smaller credit, ceteris paribus, leads to a significantly lower METR than that under equity financing (although both are negative) due to interest deductions. For illustration, panel (c) of Figure 8 combines the tax credit with immediate expensing for an equity-funded investment. From a policy standpoint, engineering identical negative METRs irrespective of the financing mode is a challenging task as the size of the credit needs to depend on the financing structure.

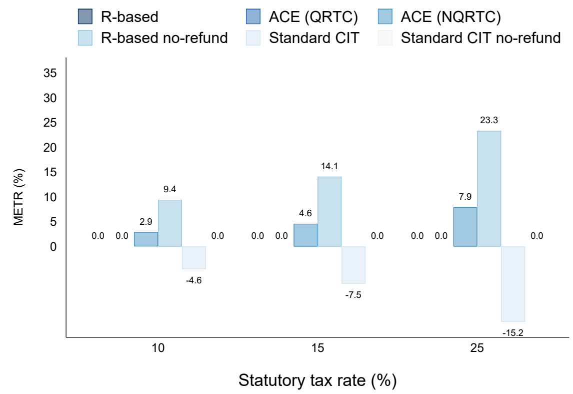
Finally, we briefly remark on the role of personal taxation in conjunction to the above profit tax designs. Under the standard CIT, high personal taxes on interest income compared to dividends and capital gains reduce corporate debt bias in the CIT, given τ; (King, 1974).[29] If equity and debt are taxed similarly at the individual level, the ACE or the cash-flow tax neutralizes corporate debt bias and retains the zero-METR result even after considering personal taxes. The minimum tax does not change this interlink between neutrality and personal taxation.

[29] Recent empirical literature examines whether investment reacts to changes in the taxation of dividends and capital gains at the individual level. Yagan (2015) and Alstadsæter et al. (2017) find that large reduction in dividends taxes had no impact to investment of U.S. and Swedish firms, respectively. This finding is consistent with the view that marginal investments are financed by retained earnings. However, using Korean data, in contrast, Moon (2022) finds that especially cash constrained firms increased investment following a reduction in the capital gains tax, suggesting an increase in their new equity financing.

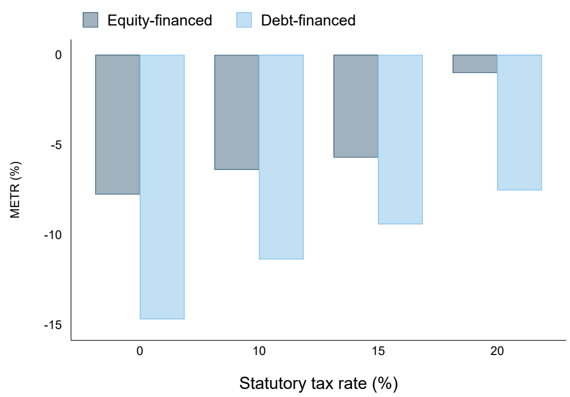
Figure 8: *METRs Across Different Tax Designs*



(a) *METRs for Fully Equity-Funded Investments*



(b) *METRs for Fully Debt-Funded Investments*



(c) *Negative METR with Refundable Tax Credits and No Full Loss Offset*

Note: METR stands for marginal effective tax rate. The figure assumes an inflation rate of 2%, a real interest rate of 5%, an economic depreciation rate of 25%, a depreciation rate for tax purposes of 25%, and an SBIT of 150%. In panels (a) and (b), labels with the annotation 'no refund' relax the assumption of full loss offset (i.e., the tax value of losses is not refunded but losses are carried forward without interest). Panel (c) combines a qualified domestic refundable tax credit with immediate expensing for an equity-funded investment (a QRTC of 2% the book value of assets) or with interest deductions for debt financed investment (assuming depreciation of 15% and a QRTC equivalent to 1% of the book value of assets.) Panel (c) relaxes the assumption of full loss offset.

7 Conclusion

We presented a comprehensive model that encompasses a standard CIT and efficient rent tax designs with different variants, to enable a coherent comparison of the METRs and AETRs on investment under these tax systems (with and without minimum taxation). even without a minimum tax, we explicitly establish the equivalence (in NPV term) between the ACE and the cash-flow tax. The value of the derivations lies in (i) underscoring the critical conditions required for the equivalence; and (ii) avoiding common pitfalls in applied analysis of the METR and AETR for an ACE country. Before introducing a minimum tax, one novel result, presented here, is that relaxing the common workhorse model assumption of refunding tax losses not only makes the ACE and the cash-flow tax inefficient, but also breaks the equivalence between them. In a scenario without refunding losses, the ACE results in a lower METR than the R-based cash-flow tax because the NPV of foregone refunds is lower.

In light of the OECD Inclusive Framework agreement (Pillar Two), the key insight of the analysis is that the minimum tax can fall on the normal return, and moreover in a particular manner, that changes the balance between the ACE and the R-based cash-flow tax. The top-up tax depends on the top-up rate and the associated top-up base, both are higher under the ACE than under the R-based cash-flow tax for moderate to low statutory CIT rates. The findings also clarify that the Pillar Two minimum tax entails debt bias as it tolerates interest deductions (that are considered as the default setting), but not notional deductions to equity (that would lower the Pillar Two effective rate).

From a policy standpoint, the analysis suggests that avoiding the top-up tax with the appropriate domestic economic rent tax design eliminates distortions to investment and financing structure. For instance, the METR for new investments is zero under an R-based cash-flow tax with a statutory CIT rate of at least 15 percent. In this system, the METR will be zero for all investments, whether made by companies that are in-scope or out-of-scope of Pillar Two. This renders a two-tier system redundant because by preventing the application of the top-up tax all companies will face the same tax treatment. Such a design becomes superior (on efficiency grounds) to, for example, a standard CIT with a statutory rate below 15 percent that results in a strictly positive METR.

A global minimum tax design should ideally not interfere with domestic efficient rent tax designs. Equivalence between efficient rent designs under minimum taxation can be achieved with the appropriate definition of the top-up tax base to reflect normal return; for example, as EBIT after deducting investment (allowing for the carryforward of unused deductions). The findings also suggest that refunding tax losses (or their carryover with interest) in the domestic system should not trigger a minimum tax.

The model presented here points to new elements that deserve a closer look in future analyses. For example, effective tax rates are defined in net present value term but Pillar Two is applied on a yearly basis. Therefore, as our model shows, the AETRs and METRs under a top-up tax depend on the realization of accounting profits in a specific year. But this ‘timing profile’ does not matter under a conventional analysis or if the top-up tax is prevented. Questions remain as to how different investment characteristics imply different timing and thus different effective rates, or to what degrees investors can influence the timing and magnitudes of accounting profits over the lifetime of the investment. Furthermore, under Pillar Two, the AETRs and METRs depend on assets and payrolls of other projects in the country through the SBIE. Further exploring this link between the payoffs of a new investment and those of existing investments is another route for future research.

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Appendix 1.

Table: High-level Summary of Key Results in Hebous and Mengistu (2024)

System	***Base***	***Efficient rent tax; METR = 0?***	***Debt bias***	***AETR (Equity)***	***AETR with a minimum tax***
Standard CIT	• Interest expense deductions • Depreciation • Full loss offset	X	✓	$\tau\left(1+\frac{\delta-\tilde{A}(r+\delta)}{p}\right)$	$\mathrm{AETR}^{CIT}+\frac{max(0,15\%-\tau)\sum_{t=1}^{\infty}\frac{\max(0,(\pi_t^c-SBIE_t))}{(1+i)^t}}{\frac{p}{r+\delta}}$
CIT without full loss offset	• Like CIT, but without refunding the value of tax losses or interest on carryforward	X	✓	No closed form solution $\mathrm{AETR}^{\mathrm{CIT}} < \mathrm{AETR}^{\mathrm{CIT,\ No\ Loss\ Offset}}$	$\mathrm{AETR}^{\mathrm{CIT,\ No\ Loss\ Offset}}+\frac{max(0,15\%-\tau)\sum_{t=1}^{\infty}\frac{\max(0,(\pi_t^c-SBIE_t))}{(1+i)^t}}{\frac{p}{r+\delta}}$
ACE	• Like CIT, but provides for deductions of normal return to equity	✓	No	$\tau\left(1-\frac{r}{p}\right)$	$\mathrm{AETR}^{ACE}+\frac{\sum_{t=1}^{\infty}max\left(0{,}15\%-\left(\frac{\tau\pi_t}{\pi_t+\tau iK_t}\right)\right)\frac{max(0,(\pi_t+\tau iK_t-SBIE_t))}{(1+i)^t}}{\frac{p}{r+\delta}I}$
ACE without full loss offset	• Like ACE, but without refunding the value of tax losses	X	No	No closed form solution $\mathrm{AETR}^{\mathrm{ACE}} < \mathrm{AETR}^{\mathrm{ACE,\ No\ Loss\ Offset}}$	$\mathrm{AETR}^{\mathrm{ACE,\ No\ Loss\ Offset}}+\frac{\sum_{t=1}^{\infty}max\left(0{,}15\%-\left(\frac{\tau\pi_t-\tau iK_t}{\pi_t}\right)\right)\frac{max(0,(\pi_t-SBIE_t))}{(1+i)^t}}{\frac{p}{r+\delta}I}$
R-based cash-flow tax	• No interest expense deductions and no taxation of interest income • Immediate 100% depreciation • Full loss offset	✓	No	$\tau\left(1-\frac{r}{p}\right)$	$\mathrm{AETR}^{R-Based}+\frac{\sum_{t=1}^{\infty}max\left(0,15\%-\tau\frac{\pi_t}{\pi_t^c}\right)\frac{max(0,(\pi_t^c-SBIE_t))}{(1+i)^t}}{\frac{p}{r+\delta}}$
R+F-based cash-flow tax	• (Sales+ borrowing+ interest received) − (purchases + interest paid + debt paid) • Full loss offset	✓	No	$\tau\left(1-\frac{r}{p}\right)$	$\mathrm{AETR}^{R-Based}+\frac{max(0,15\%-\tau)\sum_{t=1}^{\infty}\frac{max(0,(\pi_t^c-SBIE_t))}{(1+i)^t}}{\frac{p}{r+\delta}}$
S-based cash-flow tax	• Dividends paid + repurchases of shares − new equity issued • Full loss offset	✓	No	$\tau\left(1-\frac{r}{p}\right)$	$\mathrm{AETR}^{R-Based}+\frac{max(0,15\%-\tau)\sum_{t=1}^{\infty}\frac{max(0,(\pi_t^c-SBIE_t))}{(1+i)^t}}{\frac{p}{r+\delta}}$
Cash-flow tax, without full loss offset	• R-based cash-flow tax without refunding the value of tax losses or interest on carryforward	X	No	No closed form solution $\mathrm{AETR}^{\mathrm{R\text{-}Based}} < \mathrm{AETR}^{\mathrm{R\text{-}Based,\ No\ Loss\ Offset}}$	$\mathrm{AETR}^{\mathrm{R\text{-}Based,\ No\ Loss\ Offset}}+\frac{\sum_{t=1}^{\infty}max\left(0{,}15\%-\tau\frac{\pi_t}{\pi_t^c}\right)\frac{max(0,(\pi_t^c-SBIE_t))}{(1+i)^t}}{\frac{p}{r+\delta}}$

Note**:** π_t^c represents profit accounting for both loss carryforward and interest deduction, whereas π_t denotes profit prior to any interest deduction adjustments. In scenarios where a project is financed through equity, these two profit metrics converge. Hence, the top-up rate of an equity financed project in an R-based cashflow tax system simplifies to $max(0,15\%-\tau)$.

Appendix 2.

This appendix presents the main derivation of the effective tax rates in "Efficient Economic Rent Taxation under a Global Minimum Corporate Tax", by Hebous and Mengistu, 2024.

1 No Tax

Consider an investment of I unit of capital in period 0 that last until the asset is economically obsolete. Let θ be inflation, δ is real economic depreciation, and p is real economic return net of economic depreciation. The sum of economic depreciation and real return net of economic depreciation, $(p+\delta)$, equals the real return before depreciation, interest expense, and tax (i.e., EBIDTA).

The dynamics of π without taxes is:

$$\pi_0 = -I \qquad 1.1$$
$$\pi_t = (1+\theta)^t (p+\delta)(1-\delta)^{t-1}\, I \qquad \forall\ t > 0 \qquad 1.2$$

In period 0, there is no production/return. In period 1, the investment of *I* is used to produce output. The net present value of the investment is given by:

$$NPV = \sum_{t=0}^{\infty} \frac{\pi_t}{(1+i)^t} = -I + \sum_{t=1}^{\infty} \frac{(1+\theta)^t (p+\delta) \times (1-\delta)^{t-1} I}{(1+i)^t} = \frac{(p-r)I}{r+\delta} \qquad 1.3$$

where $(1+i) = (1+\theta)(1+r)$, and i is nominal interest rate.

2 Standard Corporate Income Tax (CIT)

2.1 NO MINIMUM TAX

Taxable profit under the standard CIT for this investment in period zero is:

$$\pi_0^T = -\varphi(I). \qquad 2.1$$

Since there is no return in period 0, the taxable profit is a loss that is equivalent to the capital depreciation for tax purposes, given by the function φ. The loss is refunded in the same period. This assumption is equivalent to losses being carried forward with interest.

For each period *t* after period 0, the taxable income is denoted by:

$$\pi_t^T = (1+\theta)^t (p+\delta) \times (1-\delta)^{t-1} I - \varphi(K_t) \qquad \forall\, t > 0, \qquad 2.2$$

where π_t^T is taxable profit in period *t* before adjusting for loss carry forward from previous periods. And

$$K_0 = I, K_1 = I - \varphi(I), and\ K_2 = I - \varphi(I) - \varphi\big(I - \varphi(I)\big), \dots$$

K_t is the tax depreciated asset at the beginning of period t. The accounting depreciation function, denoted as $\varphi(K)$, is assumed to be identical to tax depreciation.

Case 1: CIT with refundable tax losses:

If allowances for capital (depreciations) are refundable or carried forward with interest, the expressions for tax paid is:

$$T_0 = -\tau\varphi(I) \quad 2.3a$$
$$T_t = \tau(1+\theta)^t(p+\delta) \times (1-\delta)^{t-1}I - \tau\varphi(K_t) \qquad \forall t > 0. \quad 2.3b$$

The NPV of the total tax, T, is then calculated as:

$$T = -\sum_{t=0}^{\infty} \tau \frac{\varphi(K_t)}{(1+i)^t} + \sum_{t=1}^{\infty} \tau \frac{(1+\theta)^t(p+\delta) \times (1-\delta)^{t-1}I}{(1+i)^t}, \quad 2.4$$

$$T = -\tau A + \frac{\tau(p+\delta)I}{r+\delta}. \quad 2.5$$

The AETR is the ratio of the NPV of taxes paid to the NPV of economic returns. Under the standard CIT with refundable tax losses, the AETR is:

$$AETR = \frac{T}{\frac{p}{r+\delta}I} = \tau(1+\frac{\delta}{p}) - \tau\frac{\tilde{A}}{p/_{r+\delta}} \quad 2.6$$

The METR is the AETR that applies when economic rent is zero. Combining 1.3 and 2.5, the post-tax economic rent of the investment is expressed by the following equation.

$$VT = \frac{(p-r)I}{r+\delta} - \frac{\tau(p+\delta) \times I}{r+\delta} + \tau A,$$

The cost of capital is the economic return ($\tilde{p}$) that results in a zero post-tax economic rent. Therefore, setting VT at zero implicitly defines the cost of capital ($\tilde{p}$).

$$\tilde{p} = \frac{1}{1-\tau}\left(r+\delta-\tau\tilde{A}(r+\delta)\right) - \delta \quad 2.7$$

$$METR = \frac{\tilde{p}-r}{\tilde{p}}, \quad 2.8$$

where $\tilde{A} = A/I$.

2.1.1 DEBT BIAS

Consider a project financed with debt. Following Klemm (2008), we assume that the ratio of nominal debt to nominal market value of the asset is constant[1]:

$$\frac{debt_t}{((1-\delta)(1+\theta))^t \times I} = 1 \; \forall \; t.$$

[1] The lower the repayment of the principal, the lower is the AETR. Therefore, a project that keeps paying only the interest rate on the principal in perpetuity has the lowest AETR.

Without taxes, the project's NPV is its discounted cashflow. In period 0, the investor undertakes the investment:

$$\pi_0 = Borrowing - investment = I - I = 0 \qquad 2.9$$

In period 1, the project generates returns from production. The investor also pays some of the principal and the interest on the outstanding debt in period 0.

$$\pi_1 = (p+\delta)(1-\delta)^{1-1}(1+\theta)^1 I - \underbrace{i \times I}_{interest\ payment} - \underbrace{(1-(1-\delta)(1+\theta))\,I}_{principal\ payment} \qquad 2.10$$

Generally, following the same logic, the cashflow in each period t is expressed as follows:

$$\pi_t = I\left\{(p+\delta)(1-\delta)^{t-1}(1+\theta)^t - \underbrace{i \times \left((1-\delta)(1+\theta)\right)^{t-1} I}_{interest\ payament} - \underbrace{\left\{\left((1-\delta)(1+\theta)\right)^{t-1} - \left((1-\delta)(1+\theta)\right)^{t}\right\} I}_{principal\ payment}\right\} \qquad \forall\, t > 0 \qquad 2.11$$

Combining 2.9, 2.10, and 2.11 the economic rent of the project is:

$$V = \sum_{t=0}^{\infty} \frac{\pi_t}{(1+i)^t} = \left(\frac{p+\delta}{r+\delta}\right) I - \frac{i \times I}{1+i} - \frac{I}{1+i} - \sum_{t=1}^{\infty}\left\{\frac{i\left((1+\theta)(1-\delta)\right)^t}{(1+i)^{t+1}} + \frac{\left((1+\theta)(1-\delta)\right)^t}{(1+i)^t} - \frac{\left((1+\theta)(1-\delta)\right)^t}{(1+i)^{t+1}}\right\} \times I \qquad 2.12$$

Simplifying the expression in the curly brackets to zero, the formula for economic rent further reduces to:

$$V = \sum_{t=0}^{\infty} \frac{\pi_t}{(1+i)^t} = \left(\frac{p+\delta}{r+\delta}\right) I - I = \left(\frac{p-r}{r+\delta}\right) I \qquad 2.13$$

The calculation basis for the debt accounts for inflation. Specifically, under debt financing, it is $i \times \left((1-\delta)(1+\theta)\right)^t\ \forall\, t$.

The financing term in the standard refundable CIT system is[2]

$$-(\tau i)\sum_{t=0}^{\infty} \frac{\left((1-\delta) \times (1+\theta)\right)^t}{(1+i)^{t+1}} = -\frac{\tau i}{i - \theta + \delta \times (1+\theta)} = \frac{\tau i}{(r+\delta) \times (1+\theta)} I$$

Consequently, equations 2.5 changes to:

[2] Note that the first deduction of interest arrives at the end of period 1.

$$T = -\tau A + \frac{\tau(p+\delta)I}{r+\delta} - \frac{\tau i}{(r+\delta)\times(1+\theta)} I \qquad 2.14$$

The average effective tax rate (equation 2.6) changes to[3]:

$$AETR = \frac{T}{\frac{p}{r+\delta}I} = \tau\left(1+\frac{\delta}{p}\right) - \tau\frac{A(r+\delta)}{p} - \frac{\tau i}{(1+\theta)(r+\delta)} \times \frac{(r+\delta)}{p}$$

$$= \tau\left(1 + \frac{\delta - \tilde{A}(r+\delta)}{p} - \frac{i}{p(1+\theta)}\right) \qquad 2.15$$

To find the METR, we set economic rent to zero.

$$\frac{(\tilde{p}-r)I}{r+\delta} - \frac{\tau(\tilde{p}+\delta)I}{r+\delta} + \tau A + \frac{\tau i}{(1+\theta)(r+\delta)} I = 0$$

$$\tilde{p} = \frac{1}{1-\tau}\left(r+\delta-\tau\tilde{A}(r+\delta) - \frac{\tau i}{(1+\theta)}\right) - \delta \qquad 2.16$$

$$METR = \frac{(\tilde{p}-r)}{\tilde{p}}$$

$$= 1 - \frac{r}{\frac{1}{1-\tau}\left(r+\delta-\tau\tilde{A}(r+\delta) - \frac{\tau i}{(1+\theta)}\right) - \delta} \qquad 2.17$$

2.1.2 THE MECHANICS OF THE GLOBE RULES

Let T^c represent the total of covered domestic taxes, τ the tax rate, and π^c denote the accounting profit[4]. The top-up tax rate (τ_{topup}) is then determined by the difference between 15 percent and the ratio of T^c (covered domestic taxes) to π(accounting profit)

$$T^c = \tau \times \pi \qquad 2.18$$

$$\tau_{topup_t} = max\left(0, 15\% - \frac{T_t^c}{\pi_t^c}\right) = max\left(0, 15\% - \frac{\tau\pi_t^c}{\pi_t^c}\right) = max(0, 15\% - \tau) \qquad 2.19$$

This top-up tax rate is applied to the accounting profit in excess of the carve-out, denoted by the substance based income exclusion (SBIE). The total tax payable (*T*), domestic and top-up, in year *t* is

$$T_t = \tau\pi_t^c + max\big(0, (15\% - \tau)\big) \times max(0, \pi_t^c - SBIE_t) \qquad 2.20$$

2.2 INTRODUCING A MINIMUM TAX TO A STANDARD CIT

Proof of Proposition 1.

In the standard CIT system, the calculation of taxes paid in each period is determined by equations 2.3a and 2.3b, as previously outlined. For GloBE purposes, we assume that any tax refund from period 0 is

[3] In the standard CIT system, the typical deduction for debt in each period is denoted as $i \times \big((1+\theta)(1-\delta)\big)^t$ for all t ≥ 0 , while the deduction to account for normal return is expressed as $i \times (1-\varphi)^t$ forall $t \geq 1$. The latter leads to zero METR for all inflation and depreciation levels. On the other hand, the AETR and METR under the standard debt deduction are dependent on inflation and the depreciation rate.

[4] T^c and π^c refer to the sum of adjusted covered taxes and adjusted covered income of all constituent entities of an MNE in a jurisdiction (i.e., jurisdictional blending). T is the total tax paid by the company, including the top-up tax.

ignored since there is no profit to tax. Consequently, the taxes paid for GloBE purposes are computed as follows.

$$T_0^c = 0 \quad 2.21$$
$$T_1^c = \tau(1+\theta)(p+\delta)I - \tau\varphi(K_1) - \tau\varphi(I) \quad 2.22$$
$$T_t^c = \tau(1+\theta)^t(p+\delta)(1-\delta)^{t-1}I - \tau\varphi(K_t) \qquad \forall\, t > 1 \quad 2.23$$

In each period, the effective tax rates and additional top-up rates are determined as follows:

$$\tau_{topup_0} = 0\% \;\; since\ there\ is\ no\ profit \quad 2.24$$
$$\tau_{topup_1} = \max\,(0, 15\% - \frac{\tau\big((1+\theta)(p+\delta)I - \varphi(K_1) - \varphi(I)\big)}{(1+\theta)(p+\delta)I - \varphi(K_1) - \varphi(I)}) = \max\,(0, 15\% - \tau) \quad 2.25$$
$$\tau_{topup_t} = \max\,(0, 15\% - \frac{\tau\big((1+\theta)(p+\delta)I - \varphi(K_t)\big)}{(1+\theta)(p+\delta)I - \varphi(K_t)} = \max\,(0, 15\% - \tau) \quad 2.26$$

The NPV of the stream of top-up taxes paid by the company is calculated as follows.

$$\sum_{t=1}^{\infty} max\,(0, 15\% - \tau)\frac{max\,(0, (\pi_t^c - SBIE_t))}{(1+i)^t} \quad 2.27$$

Combining the taxes paid in the standard CIT in the absence of pre-GloBE (equation 2.5) and the additional tax due to the GloBE, the NPV of total taxes paid is expressed as:

$$T = -\tau A + \frac{\tau(p+\delta)I}{r+\delta} + \sum_{t=1}^{\infty} max\,(0, 15\% - \tau)\frac{\max\big(0, (\pi_t^c - SBIE_t)\big)}{(1+i)^t} \quad 2.28$$

Finally, the resulting average effective tax rate is calculated as:

$$AETR = \tau\left(1 + \frac{\delta}{p}\right) - \tau\frac{\tilde{A}}{p/_{r+\delta}} + \frac{\sum_{t=1}^{\infty} max\,(0, 15\% - \tau)\frac{\max\big(0, (\pi_t^c - SBIE_t)\big)}{(1+i)^t}}{p/_{r+\delta}} \quad 2.29$$

Implications:

1. If $\tau < 15\%$, the top-up tax rate is positive. Therefore, a top-up tax applies if profit is higher than SBIE, and the AETR of the standard CIT + QDMTT is higher than the AETR of the standard CIT system.
   Proof: Since account profit and covered profit are similar, the GloBE ETR is similar to the statutory tax rate, hence there will be a positive top-up rate in at least one period If $\tau < 15\%$. Therefore, the second part of equation 4.9 would be strictly positive if $(\pi_t^c - SBIE_t) > 0$ for at least one period.

2. If $\tau \geq 15\%$, the top-up tax rate is zero throughout the entire life of the investment. The pure standard CIT system is similar to the standard CIT under GloBE.
   Proof: In a similar argument as above, the GloBE ETR and the statutory tax rates are similar. Therefore, the top-up tax rate (i.e., $max\,(0, 15\% - \tau)$) is zero for any statutory tax rate above 15%. Therefore, the top-up in any period given by $max\,(0, 15\% - \tau) * \max\big(0, (\pi_t^c - SBIE_t)\big)$ is zero. Therefore, the system collapses to the AETR and METR of a standard CIT shown in equations 2.6 and 2.8.

Proof of proposition 2.

If the SBIE is equivalent to a normal return, then for a wide range of parameters, a top-up tax becomes applicable in at least one period t. In such scenarios, normal returns are subject to taxation if the statutory tax rate is below 15% ($\tau < 15\%$). Specifically, excess profit is positive for at least one period if inflation is high or if tax depreciation is low. The following discussion demonstrates these conditions. We interpret the condition where SBIE equals normal return as the NPV of the SBIE stream being equal to the NPV of a real interest return in each period. Mathematically, this is represented as:

$$\sum_{t=1}^{\infty} \frac{SBIE_t}{(1+i)^t} = \frac{r}{r+\delta}$$

For this condition to be satisfied, the formula for the SBIE must be

$$SBIE_t = r(1-\delta)^{t-1}(1+\theta)^t \qquad \forall\, t \geq 1$$

Consider the case of an investment that earns a normal return, $p = r$. Suppose tax depreciation is a multiple of economic depreciation, $\varphi = \alpha\delta$, where $0 < \alpha \leq \frac{1}{\delta}$. As α increases, tax depreciation also increases. In the limit $\alpha\delta = 1$.

Under GloBE, if the profit in each period, accounting for loss carryforward, is negative, then the losses are carried forward indefinitely.

$$\pi_1^c = \underbrace{(r+\delta)(1+\theta) - \alpha\delta(1-\alpha\delta)}_{accoutnng\ profit\ in\ period\ 1} - \underbrace{\alpha\delta}_{loss\ carryforward\ from\ period\ 0} \tag{2.30}$$

If $\pi_1^c < 0$

$$\pi_2^c = \underbrace{(r+\delta)(1+\theta)^2(1-\delta) - \alpha\delta(1-\alpha\delta)^2}_{accoutnng\ profit\ in\ period\ 2} + (\underbrace{(r+\delta)(1+\theta) - \alpha\delta(1-\alpha\delta)}_{accoutnng\ profit\ in\ period\ 1} - \underbrace{\alpha\delta}_{loss\ carryforward\ from\ period\ 0}) \tag{2.31}$$

Following similar steps, it is straightforward to show that:

If $\pi_{T-1}^c < 0$

$$\pi_T^c = \sum_{t=1}^{T} (r+\delta)(1+\theta)^t (1-\delta)^{t-1} - \alpha\delta \sum_{t=0}^{T} (1-\alpha\delta)^t \qquad \forall\, T > 0 \tag{2.32}$$

Equation 2.32 is a positive function of inflation (θ), normal return (r) and a decreasing function of $\alpha\delta$. Therefore, for higher inflation or higher normal return or lower tax depreciation, a positive profit occurs in earlier periods.

In the period where $\pi_T^c > 0$, i.e., period *T*, excess profit is expressed as:

$$\pi_T^{excess} = \pi_T^c - SBIE_t$$

$$\pi_T^{excess} = \sum_{t=1}^{T} (r+\delta)(1+\theta)^t (1-\delta)^{t-1} - \alpha\delta \sum_{t=0}^{T} (1-\alpha\delta)^t - r(1-\delta)^{t-1}(1+\theta)^t$$

$$\pi_T^{excess} = \sum_{t=1}^{T-1} (r+\delta)(1+\theta)^t (1-\delta)^{t-1} - \alpha\delta \sum_{t=0}^{T} (1-\alpha\delta)^t \quad 2.33$$

As inflation (θ) increases, the expression in equation 2.33 is obviously positive for some time period T. Let's instead take the extreme cases where inflation is very low ($\theta = 0$) and tax depreciation is 100 percent.

Equation 2.33 simplifies to

$$\pi_T^c = \frac{r+\delta}{\delta}(1-(1-\delta)^T) - 1$$

This is obviously positive for some period T. Then, in period T+1, the excess profit is given by:

$$\pi_T^{excess} = (r+\delta)(1-\delta)^T - r(1-\delta)^T = \delta(1-\delta)^T > 0 \quad 2.34$$

Equation 2.34 shows that even under the extreme assumptions of zero inflation and immediate expensing for tax purposes, there is at least one period *t* where the excess profit is positive. The institution for this result is that the SBIE is not carried forward.

2.3 TAX INCENTIVES UNDER A STANDARD CIT AND A MINIMUM TAX

The two types of tax credits under the GloBE rules are: qualified refundable tax credits (QRTCs) and non-qualified refundable tax credits (NQRTCs). A QRTC is a refundable tax credit paid as cash or an equivalent within four years[5]. This increases the GloBE covered income by the full amount of the credit (*X*).

The total tax paid by the company in any period is:

$$T_t^Q = \underbrace{T_t^c - X_t}_{Domestic\ tax} + \underbrace{max\left(0, \left(15\% - \frac{T_t^c}{\pi_t^c + X_t}\right)\right) \times max\ (0, \pi_t^c + X_t - SBIE_t)}_{Top\ up} \quad 2.35$$

$$T_t^Q = \underbrace{\tau\pi^c - X_t}_{Domestic\ tax} + \underbrace{ma\,x\left(0, \left(15\% - \frac{\tau\pi_t^c}{\pi_t^c + X_t}\right)\right) max\ (0, \pi_t^c + X_t - SBIE_t)}_{Top\ up} \quad 2.36$$

$$ATR^Q = \tau - \frac{X_t}{\pi_t^c} + max\ (0, \left(15\% - \left(\frac{\tau\pi_t^c}{\pi^c + X_t}\right)\right) max\left(0, 1 + \frac{X_t}{\pi_t^c} - \frac{SBIE_t}{\pi_t^c}\right) \quad 2.37$$

A NQRTC is treated as a reduction in covered taxes[6]:

$$T_t^N = \underbrace{T_t^c - X_t}_{Domestic\ tax} + max\ (0, \underbrace{\left(15\% - \left(\frac{\tau\pi_t^c - X_t}{\pi_t^c}\right)\right)) max(0, \pi_t^c - SBIE_t)}_{Top\ up} \quad 2.38$$

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[5] Also, for the refund to be a QRTC, its amount must not be limited to any 'tax liability'.

[6] It should be noted that this analysis abstracts away from scenarios where the tax credit exceeds the taxes owed. In these instances, NQRTCs are deferred to future periods for offsetting against prospective tax obligations. Consequently, in all considered periods, the relationship $\tau\pi_t^c \geq X_t$ holds. Tax credits utilized in subsequent periods are of decreased value to the firm due to the time value of money. This aspect represents a further dimension wherein QRTCs hold greater value than NQRTCs under most realistic parameters.

$$T_t^N = \underbrace{\tau \times \pi_t^c - X_t}_{Domestic\ tax} + \underbrace{max\ (0, \left(15\% - \left(\frac{\tau * \pi_t^c - X_t}{\pi_t^c}\right)\right))\ max(0, \pi_t^c - SBIE_t)}_{Top\ up} \quad 2.39$$

$$ATR^N = \tau - \frac{X}{\pi_t^c} + max\ (0, \left(15\% - \left(\tau - \frac{X_t}{\pi_t^c}\right)\right) max\left(0{,}1 - \frac{SBIE_t}{\pi_t^c}\right) \quad 2.40$$

Proof of Proposition 3, part a.

QRTC:

Case 1: $\pi_t^c > SBIE_t$
Case 1.1: $\tau < 15\%$:

For all positive values of X, the term $\left(15\% - \frac{\tau\pi_t^c}{\pi_t^c + X_t}\right)$ remains below 15%.

Tax Calculation:

Before tax credit: $\tau\pi^c + \left(15\% - \frac{\tau\pi_t^c}{\pi_t^c}\right)(\pi_t^c - SBIE_t)$

After the tax credit:

$T_t^Q = \tau\pi^c - X_t + \left(15\% - \frac{\tau\pi_t^c}{\pi_t^c + X_t}\right)(\pi_t^c + X_t - SBIE_t) = \tau\pi^c + \left(15\% - \frac{\tau\pi_t^c}{\pi_t^c}\right)(\pi_t^c - SBIE_t) - 0.85\% \times X_t - \left(\frac{\tau\pi_t^c}{\pi_t^c + X_t}\right)(\pi_t^c + X_t - SBIE_t)$

Under this scenario, the post-credit tax is below the pre-credit tax even if the SBIE is zero.

Case 1.2: $\tau > 15\%$:

For small positive values of *X*, $\left(15\% - \frac{\tau\pi_t^c}{\pi_t^c + X_t}\right)$ continues to be above 15% and a top-up tax does not apply.

The tax paid by the company is:

Before tax credit: $\tau\pi^c$

And the tax after credit: $\tau\pi^c - X_t$

Which is less than the pre-credit tax. In other words, when the SBIE is very large, the company receives 100 percent of the tax credit.

As *X* increases, the effective covered tax rate decreases below 15%.

Before tax credit: $\tau\pi_t^c$

After the tax credit

$T_t^Q = \tau\pi^c - X_t + \left(15\% - \frac{\tau\pi_t^c}{\pi_t^c + X_t}\right)(\pi_t^c + X_t - SBIE_t) = \tau\pi^c + (15\% - \tau)(\pi_t^c - SBIE_t) - 0.85\%\ X_t - \left(\frac{\tau\pi_t^c}{\pi_t^c + X_t}\right)(\pi_t^c + X_t - SBIE_t) < \tau\pi^c$

Under this scenario, the post-credit tax decreases even if the SBIE is zero.

Case 2: $\pi_t^c < SBIE_t$

2.1 For small value of X_t , $\pi_t^c + X_t < SBIE_t$ which implies that the top-up tax is zero for all tax rates (τ).
Before credit: $\tau\pi_t^c$
And the after credit: $T_t^Q = \tau\pi^c - X_t$

2.2 As X_t increases, $\pi_t^c + X_t > SBIE_t$ and a top-up tax applies depending on the statutory tax rate.

2.2.1 $15\% < \frac{\tau\pi_t^c}{\pi_t^c+X_t}$. In this case, the top-up tax rate is zero even after the tax credit. Therefore,

Before credit : $\tau\pi_t^c$
And the after credit: $T_t^Q = \tau\pi^c - X_t$

2.2.2 $\frac{\tau\pi_t^c}{\pi_t^c+X_t} < 15\% < \tau$, which implies that $X_t > (\tau - 15\%) * \pi_t^c$
Before tax credit: : $\tau\pi_t^c$
After tax credit $T_t^Q = \tau\pi^c - X_t + \left(15\% - \frac{\tau\pi_t^c}{\pi_t^c+X_t}\right)(\pi_t^c + X_t - SBIE_t) = \tau\pi^c + (15\% - \tau)(\pi_t^c - SBIE_t) -$
$0.85\% * X_t - \left(\frac{\tau\pi_t^c}{\pi_t^c+X_t}\right)(\pi_t^c + X_t - SBIE_t) < \tau\pi^c$

NQRTC

Case 1: $\pi_t^c \leq SBIE_t$
The tax before the credit is

$$\tau\pi_t^c + max\left(0{,}15\% - \frac{\tau\pi_t^c}{\pi_t^c}\right)(0) = \tau\pi_t^c$$

And the tax after the credit is

$$\tau\pi_t^c - X < \tau\pi_t^c$$

That is, when the SBIE is very large, the project receives 100 percent of the tax credit.

Case 2: $\pi_t^c > SBIE_t$
Case 2.1: $\tau \leq 15\%$

For low values of x, $0 < \left(\frac{\tau\pi_t^c - X_t}{\pi_t^c}\right) \leq 15\%$, and a top up tax continues to be applied.
The tax before the credit is

$$\tau\pi_t^c + (15\% - \tau) \times (\pi_t^c - SBIE_t)$$

And the tax after credit is

$$T_t^N = \underbrace{\tau\pi_t^c - X_t}_{Domestic\ tax} + \underbrace{\left(15\% - \left(\frac{\tau\pi_t^c - X_t}{\pi_t^c}\right)\right)}_{Top\ up}(\pi_t^c - SBIE_t),$$

which can be simplified to
$T_t^N = \tau\pi_t^c + (15\% - \tau)(\pi_t^c - SBIE_t) - X \times (SBIE_t/\pi_t^c) < \tau\pi_t^c + (15\% - \tau)(\pi_t^c - SBIE_t)$

Note that the tax paid after the credit is lower than the tax due before the credit. However, the decrease depends on the SBIE.

As *X* further increases, the expression $\left(\frac{\tau\pi_t^c - X_t}{\pi_t^c}\right)$ approaches zero and the top-up tax rate approaches 15%. This is the case if $X_t = \tau\pi_t^c + \in$, where $\in > 0$. The expression

$$T_t^N = \tau\pi_t^c + (15\% - \tau)(\pi_t^c - SBIE_t) - X^{SBIE_t}/_{\pi_t^c}$$

Can be further simplified to:

$$T_t^N = \tau\pi_t^c - X_t + 15\% \times (\pi_t^c - SBIE_t) = \tau\pi_t^c - \tau\pi_t^c - \in + 15\% \times (\pi_t^c - SBIE_t)$$

Further simplification leads to

$$T_t^N = \tau\pi_t^c + (15\% - \tau)(\pi_t^c - SBIE_t) - \tau \times SBIE_t - \in < \tau\pi_t^c + (15\% - \tau)(\pi_t^c - SBIE_t)$$

Case 2.2: $\tau > 15\%$

$$T_t^N = \tau\pi_t^c - X_t < \tau\pi_t^c$$

For low enough, $\left(\frac{\tau\pi_t^c - X_t}{\pi_t^c}\right)$ continues to be above 15%.

Then the expression

$$T_t^N = \underbrace{\tau\pi_t^c - X_t}_{Domestic\ tax} + \underbrace{\left(15\% - \left(\frac{\tau\pi_t^c - X_t}{\pi_t^c}\right)\right)(\pi_t^c - SBIE_t)}_{Top\ up}$$

can be simplified to

$$T_t^N = \tau\pi_t^c - X < \tau\pi_t^c$$

That is, when the SBIE is very large, the project receives 100 percent of the tax credit.

As *X* increases, $\left(\frac{\tau\pi_t^c - X_t}{\pi_t^c}\right)$ eventually becomes less than 15%. This is equivalent to the case where

$$\frac{\tau\pi_t^c - X_t}{\pi_t^c} < 15\% < \tau$$

Then

$$T_t^N = \underbrace{\tau\pi_t^c - X_t}_{Domestic\ tax} + \underbrace{\left(15\% - \left(\frac{\tau\pi_t^c - X_t}{\pi_t^c}\right)\right)(\pi_t^c - SBIE_t)}_{Top\ up}$$

Which can be simplified to

$$T_t^N = \tau\pi_t^c + (15\% - \tau)(\pi_t^c - SBIE_t) - X \times {}^{SBIE_t}/_{\pi_t^c} < \tau\pi_t^c + (15\% - \tau)(\pi_t^c - SBIE_t)$$

Summary: The tax after an NQRTC is lower than before the tax credit. However, under some conditions the decrease depends on the SBIE.

Proof of Proposition 3, part b.

Provided that there is a positive top-up tax in both systems, QRTC tends to be more beneficial in scenarios with a minimal carveout (↓ SBIE). On the other hand, NQRTCs are more advantageous in situations where there is a significantly high carveout (↑ SBIE).

$$T_t^Q - T_t^N$$
$$= \underbrace{\tau\pi^c - X_t}_{Domestic\ tax} + \underbrace{max\left(0,\ \left(15\% - \frac{\tau\pi_t^c}{\pi_t^c + X}\right)\right) \max\left(0, (\pi^c + X_t - SBIE_t)\right)}_{Top\ up} - (\underbrace{\tau\pi_t^c - X_t}_{Domestic\ tax})$$
$$+ \max\left(0, \underbrace{\left(15\% - \left(\frac{\tau\pi_t^c - X_t}{\pi_t^c}\right)\right) \max\left(0(\pi_t^c - SBIE_t)\right)}_{Top\ up}\right)$$

Case 1: $15\% > \left(\frac{\tau\pi_t^c - X_t}{\pi_t^c}\right)$. The top-up tax rate is zero under both tax credit systems. As a result, in both systems the company receives 100 percent of the credit.

Case 2: $\frac{\tau\pi_t^c}{\pi_t^c + X} < 15\% < \left(\frac{\tau\pi_t^c - X_t}{\pi_t^c}\right)$. A top-up tax applies under the NQRTC but not under QRTC, as long as $(\pi_t^c - SBIE_t) > 0$. Therefore, the total tax paid would be higher under NQRTC.

Case 3: In a high carveout situation where $(\pi_t^c - SBIE_t) \leq 0\ and\ (\pi_t^c + X_t - SBIE_t) > 0\ and\ 15\% < \frac{\tau\pi_t^c}{\pi_t^c + X_t}$ there is no top-up tax under NQRTC whereas a positive top up tax applies under QRTC. As a result, the total tax paid is higher under QRTC.

Case 4: For a top-up tax to apply in both systems, the following conditions must hold.

$$15\% > \frac{\tau\pi_t^c}{\pi_t^c + X_t}\ and\ (\pi_t^c - SBIE_t) > 0$$

Under this condition:

$$T_t^Q - T_t^N = X_t\left(-85\% + \frac{SBIE_t}{\pi_t^c}\left(1 - \frac{\tau}{1 + \frac{X_t}{\pi_t^c}}\right)\right)$$

For instance, if SBIE=0, the total tax under QRTC and NQRTC, respectively simplify to:

$$T_t^Q = 15\% \times \pi_t^c - 85\% \times X_t$$

$$T_t^N = 15\% \times \pi_t^c$$

2.3.1 EXPLICIT EXPRESSION FOR AETR AND METR UNDER CIT AND MINIMUM TAX

If we make the strong assumption that the SBIE always aligns with profitable periods or that the firm aligns its investments in a way that enables it to take full advantage of the SBIE, we can eliminate the non-linear function (i.e., the max expression above).

Let the ratio of payroll to investment be denoted by α. Since the SBIE in each period is 5% of tangible assets and 5% of payroll at the end of each period, the period-by-period SBIE can be expressed as follows:

$$SBIE_t = 5\%\ x\ K_t + 5\%\ x\ \alpha\ x\ K_t = 5\%\ x\ (1+\alpha)\ x\ K_t \qquad 2.40$$

The NPV of the SBIE is expressed as follows:

$$NPV_{SBIE} = \sum_{t=1}^{\infty} \frac{5\%\ x\ (1+\alpha)\ x\ K_t}{(1+i)^t} \qquad 2.41$$

Where:

$$K_1 = I - \varphi(I), K_2 = I - \varphi(I) - \varphi\big(I - \varphi(I)\big), \ldots$$

Therefore,

$$NPV_{SBIE} = \frac{5\%\ x\ (1+\alpha)}{i}\ (I - A) \qquad 2.42$$

If the top-up rate is positive, because $\tau < 0$, the top-up tax of an equity financed project can be expressed as:

$$top - up\ tax = (15\% - \tau)\ x\ \left(-A + \frac{(p+\delta)I}{r+\delta} - \frac{5\%\ x\ (1+\alpha)}{i}\ (I - A)\right) \qquad 2.43$$

Total tax paid is expressed as

$$T = \tau\left(-A + \frac{(p+\delta)I}{r+\delta}\right) + (15\% - \tau)\ x\ \left(-A + \frac{(p+\delta)I}{r+\delta} - \frac{5\%\ x\ (1+\alpha)}{i}\ (I - A)\right)$$

$$T = 15\%\ x\ \left(-A + \frac{(p+\delta)I}{r+\delta}\right) - (15\% - \tau)\left(\frac{5\%\ x\ (1+\alpha)}{i}\ (I - A)\right) \qquad 2.44$$

The average effective tax rate if given by

$$AETR = 15\%\ \left(\left(1 + \frac{\delta}{p}\right) - \frac{\tilde{A}}{p/_{r+\delta}}\right) - (15\% - \tau)\left(\frac{5\%\ x\ (1+\alpha)}{i}\left(\frac{1-\tilde{A}}{p/_{r+\delta}}\right)\right) \qquad 2.45$$

To find the METR, we first identify the expression for the cost of capital: the economic return that would result in a zero post tax economic rent.

$$\frac{(\tilde{p} - r)I}{r+\delta} - 15\%\ x\ \left(-A + \frac{(\tilde{p}+\delta)I}{r+\delta}\right) + (15\% - \tau)\left(\frac{5\%\ x\ (1+\alpha)}{i}\ (I - A)\right) = 0$$

$$\tilde{p} = \frac{1}{85\%}\left(r + \delta - 15\%\ x\ \tilde{A}\ x\ (r+\delta) - (15\% - \tau)x\ \left(\frac{5\%\ x\ (1+\alpha)}{i}\right)\ x\ \big(1 - \tilde{A}\big)\ x\ (r+\delta)\right) - \delta \qquad 2.46$$

$$METR = 1 - \frac{r}{\frac{1}{85\%}\left(r + \delta - 15\%\ x\ \tilde{A}\ x\ (r+\delta) - (15\% - \tau)x\ \left(\frac{5\%\ x\ (1+\alpha)}{i}\right)\ x\ \big(1 - \tilde{A}\big)\ x\ (r+\delta)\right) - \delta} \qquad 2.47$$

For a debt financed project, the equivalent expressions are:

$$T = 15\%\ x\ \left(-A + \frac{(p+\delta)I}{r+\delta} - \frac{i\ x\ I}{(r+\delta)(1+\theta)}\right) - (15\% - \tau)\left(\frac{5\%\ x\ (1+\alpha)}{i}\ (I - A)\right) \qquad 2.48$$

$$AETR = 15\%\ \left(\left(1 + \frac{\delta}{p}\right) - \frac{\tilde{A}}{p/_{r+\delta}} - \frac{i}{p\ x\ (1+\theta)}\right) - (15\% - \tau)\left(\frac{5\%\ x\ (1+\alpha)}{i}\left(\frac{1-\tilde{A}}{p/_{r+\delta}}\right)\right) \qquad 2.49$$

$$\tilde{p} = \frac{1}{85\%}\left(r + \delta - 15\%\, x\, \tilde{A}\, x\, (r+\delta) - 15\% \frac{i}{1+\theta} - (15\% - \tau) x \left(\frac{5\%\, x\, (1+\alpha)}{i}\right) x \left(1 - \tilde{A}\right) x\, (r+\delta)\right) - \delta \qquad 2.50$$

$$METR = 1 - \frac{r}{\frac{1}{85\%}\left(r + \delta - 15\%\, x\, \tilde{A}\, x\, (r+\delta) - 15\% \frac{i}{1+\theta} - (15\% - \tau) x \left(\frac{5\%\, x\, (1+\alpha)}{i}\right) x \left(1 - \tilde{A}\right) x\, (r+\delta)\right) - \delta} \qquad 2.51$$

3 R-Based Cash Flow Tax

Since the investment in period 0 is immediately expensed,

$$\varphi(K_0) = I, and\ \varphi(K_t) = 0\ \forall\ t > 0 \qquad 3.1$$

which implies:

$$A = \sum_{t=0}^{\infty} \frac{\varphi(K_t)}{(1+i)^t} = I \qquad 3.2$$

The NPV of total tax paid is given by:

$$T = -\tau I + \sum_{t=1}^{\infty} \tau \frac{(1+\theta)^t (p+\delta) \times (1-\delta)^{t-1} I}{(1+i)^t} = -\tau I + \frac{\tau(p+\delta)}{r+\delta} I = \frac{\tau(p-r)}{r+\delta} I \qquad 3.3$$

The AETR of an R-based cashflow tax system is:

$$AETR = \frac{\frac{\tau(p-r)}{r+\delta} I}{\frac{p}{r+\delta} I} = \tau\left(1 - \frac{r}{p}\right). \qquad 3.4$$

Comparing 5.3 and 2.14, we see that R-based cashflow tax system results in a higher amount of the taxes paid compared to debt finance under the standard CIT system, for a large set of reasonable parameters.

$$T_{R-based} - T_{debt\ finance\ standard\ CIT} = \frac{\tau(p-r)}{r+\delta} I - \left(-\tau A + \frac{\tau(p+\delta) I}{r+\delta} - \frac{\tau i}{i - \theta + \delta * (1+\theta)} I\right)$$

$$= \tau \left\{ \frac{\left(\frac{\theta}{1+\theta} - \delta\right)}{r+\delta} + A \right\} \times I$$

This expression demonstrates that the AETR under a CIT with debt finance is not neutral with respect to inflation and depreciation.

3.1.1 DIFFERENCE BETWEEN R-BASED CASHFLOW TAX AND IMMEDIATE EXPENSING

The R-based cashflow tax implies that losses are either immediately refunded or carried forward with interest. Under this system we have shown that METR is zero and taxes are applied only on economic rent (equation 5.4). In contrast, immediate expensing does not necessarily imply that losses are refunded or carried froward with interest. To highlight the implication of this difference, suppose the project carries forward the initial expense into next periods until the losses are completely exhausted, and suppose first period profit is sufficient to exhaust the losses that are carried forward. The NPV of taxes paid is:

$$T = -\frac{\tau I}{1+i} + \sum_{t=1}^{\infty} \tau \frac{(1+\theta)^t (p+\delta)\times(1-\delta)^{t-1} I}{(1+i)^t} = -\frac{\tau I}{1+i} + \tau I - \tau I + \sum_{t=1}^{\infty} \tau \frac{(1+\theta)^t (p+\delta)\times(1-\delta)^{t-1} I}{(1+i)^t}$$
$$T = \frac{\tau i}{1+i} \quad + \frac{\tau(p-r)}{r+\delta}$$

$$AETR = \frac{\frac{\tau(p-r)}{r+\delta}}{\frac{p}{r+\delta}} + \frac{\frac{\tau i}{1+i}}{(\frac{p}{r+\delta})} = \tau\left(1-\frac{r}{p}\right) + \frac{\frac{\tau i}{1+i}}{(\frac{p}{r+\delta})} = \tau\left(1-\frac{r}{p}\right) + \frac{\tau}{p}\left(r+\frac{\theta}{(1+\theta)}\right)\frac{r+\delta}{1+r}, \qquad 3.5$$

which is an increasing function of inflation.

More generally, the losses carried forward from the first period would be exhausted at some period *N*, where *N* is given by:

$$\sum_{t=1}^{N} (1+\theta)^t (p+\delta) \times (1-\delta)^{t-1} I = I \qquad 3.6a$$

As economic return, p, increases, the time period necessary for the loss carryforward decreases. For high enough p, *N=1* and equation 5.5 applies. Similarly, for high enough inflation, *N* approaches 1, and equation 5.3 applies. However, the resulting NPV of taxes is higher due to the higher inflation.

In the periods before *N*, the company does not pay taxes. Therefore, the NPV of taxes paid is characterized as follows:

$$T = \sum_{t=N+1}^{\infty} \tau \frac{(1+\theta)^t (p+\delta) \times (1-\delta)^{t-1} I}{(1+i)^t} \qquad 3.6b$$

Comparing 5.6b with equation 5.3, the NPV of taxes paid under a refundable R-based cash flow tax regime is lower than that under a non-refundable system.

Subtracting 3.6b from 3.3 results in:

$$\begin{aligned} -\tau I + \sum_{t=1}^{\infty} \tau \frac{(1+\theta)^t (p+\delta) \times (1-\delta)^{t-1} I}{(1+i)^t} \\ - \sum_{t=N+1}^{\infty} \tau \frac{(1+\theta)^t (p+\delta) \times (1-\delta)^{t-1} I}{(1+i)^t} \\ = -\tau I + \sum_{t=1}^{N} \tau \frac{(1+\theta)^t (p+\delta) \times (1-\delta)^{t-1} I}{(1+i)^t} \end{aligned} \qquad 3.6c$$

However, we have established in 5.6a that $\sum_{t=1}^{N} (1+\theta)^t (p+\delta) \times (1-\delta)^{t-1} I = I$. Hence, 5.6c simplifies to:

$$\tau\left(\sum_{t=1}^{N}\tau\frac{(1+\theta)^t(p+\delta)\times(1-\delta)^{t-1}I}{(1+i)^t}-\sum_{t=1}^{N}(1+\theta)^t(p+\delta)\times(1-\delta)^{t-1}I\right)<0$$

Using 5.6c, the AETR under non-refundability can be expressed as:

$$AETR=\frac{\sum_{t=N+1}^{\infty}\tau\frac{(1+\theta)^t(p+\delta)\times(1-\delta)^{t-1}}{(1+i)^t}}{P/(r+\delta)}$$

Alternatively

$$AETR=\frac{\sum_{t=1}^{\infty}\tau\frac{(1+\theta)^t(p+\delta)\times(1-\delta)^{t-1}}{(1+i)^t}-\sum_{t=1}^{N}\tau\frac{(1+\theta)^t(p+\delta)\times(1-\delta)^{t-1}}{(1+i)^t}-\tau I+\tau I}{P/(r+\delta)}$$

Further simplifying leads to

$$AETR=\tau\left(1-\frac{r}{p}\right)+\frac{I-\sum_{t=1}^{N}\tau\frac{(1+\theta)^t(p+\delta)\times(1-\delta)^{t-1}}{(1+i)^t}}{P/(r+\delta)} \qquad 3.6d$$

It is straightforward to demonstrate that METR is greater than zero. For instance, when $p=r$, equation 5.6d reduces to:

$$AETR=\tau\left(1-\frac{r}{r}\right)+\tau\frac{1-\left(\frac{(1-\delta)}{(1+r)}\right)^N}{r/_{r+\delta}}=\tau\frac{1-\left(\frac{(1-\delta)}{(1+r)}\right)^N}{r/_{r+\delta}}>0$$

The marginal effective tax rate is the economic return ($\tilde{p}$), that leads to zero post-tax economic rent, and it is implicitly defined by equation 5.7e below.

$$0=\left(\frac{\tilde{p}-r}{r+\delta}\right)-\tau\left(\frac{\tilde{p}-r}{r+\delta}\right)+\ \tau\frac{\tilde{p}+\delta}{r+\delta}(1-\left(\frac{(1-\delta)}{(1+r)}\right)^N \qquad 3.6e$$

$$METR=\frac{(\tilde{p}-r)}{\tilde{p}}$$

3.1.2 THE EQUIVALENCE OF R-BASED, R+F, AND S-BASED CASH-FLOW TAXES

The tax base of the R+F based cash-flow tax includes non-equity financial transactions in addition to the tax base of the R-base cash-flow tax.

R+F base = (sales+ borrowing+ interest received) − (purchases + interest paid + debt paid)

If the project is financed through equity, it can readily be seen that the tax base of the R+F-based and the R-based cash-flow tax systems are equivalent, as the above definition of the tax base boils down to *sales minus purchases.*

Considering a fully-debt debt-financed project, in the initial period 0, the cash-flow involves an investment '*I*' and an equal amount of borrowing '*I*', making the taxable income zero:

$$\pi_0^T=\underbrace{I}_{borrowing}-\underbrace{I}_{investment}=0 \qquad 3.7$$

In subsequent periods *t*, the project's cash-flow includes production income, debt principal repayments, and interest payments on the outstanding debt in period (*t-1*).

$$\pi_t^T = \underbrace{(1+\theta)^t(p+\delta)\times(1-\delta)^{t-1}I}_{proceeds\ from\ production} - \underbrace{principal_t}_{principal\ payment\ in\ period\ t} - \underbrace{i\times(I-\sum_{t=0}^{t-1}principal_t)}_{interest\ payment\ on\ outstanding\ loan\ in\ period\ (t-1)} \quad \forall\, t>0 \qquad 3.8$$

The NPV of economic rent is:

$$V = \underbrace{\frac{p+\delta}{r+\delta}}_{The\ NPV\ from\ production} - \underbrace{I}_{NPV\ of\ interets\ on\ the\ original\ loan} = \frac{p-r}{r+\delta} \qquad 3.9$$

Note that each principal repayment reduces taxable income in the period of payment but increases taxable income in later periods due to decreased interest payments. These effects exactly offset each other. For example, for the principal paid in period 1, equation 5.8 implies:

$$-\frac{principal_1}{1+i} + i\times\sum_{t=2}^{\infty}\frac{principal_1}{(1+i)^t} = -\frac{principal_1}{1+i} + \frac{principal_1}{1+i} = 0$$

In terms of taxes,

$$T_0 = 0 \qquad 3.10$$

$$T_t = \tau\left\{\underbrace{(1+\theta)^t(p+\delta)\times(1-\delta)^{t-1}I}_{proceeds\ from\ production} - \underbrace{principal_t}_{principal\ payment\ in\ period\ t} - \underbrace{i\times(I-\sum_{t=0}^{t-1}principal_t)}_{interest\ payment\ on\ outstanding\ loan\ in\ period\ (t-1)}\right\} \quad \forall\, t>0 \qquad 3.11$$

Combining equations 5.9 and 5.11, the NPV of taxes paid by the project can be expressed as:

$$T = \frac{\tau(p-r)}{r+\delta}I \qquad 3.12$$

And the AETR is:

$$AETR = \frac{\frac{\tau(p-r)}{r+\delta}I}{p/(r+\delta)} = \tau\left(1-\frac{r}{p}\right). \qquad 3.13$$

S-based cash-flow tax: The tax base for the S-based cash-flow tax is the net flow from corporations to shareholders:

dividends paid + purchases of shares − new equity issued.

If we abstract away from the possibility of retained earnings, it is easy to show the equivalence between the tax base of the S-based cashflow tax and the R+F-based cashflow tax using basic accounting identity. Since the sources of funds should equal the use of funds, any positive cashflow emanating from sales, interest, and borrowing, after accounting for expenses and debt payment (both interest and principal), needs to be distributed to shareholders as outright payment (dividends) or repurchase of shares. If the cashflow is negative, it needs to be financed by the issuance of new equity. This implies:

(dividends paid + purchases of shares − new equity issued) = (sales+ borrowing+ interest received) − (purchases + interest paid + debt paid)

The right hand side of this equation is the R+F tax base we have shown above.

Now consider the possibility of retained earnings. In the following, we demonstrate that the system yields a similar result in NPV terms to an R+F system if retained earnings are ultimately taxed.

Suppose in period 0, the company issues new equity equivalent to *I*. Since dividends and purchases of shares are zero, taxable income is only the issue of new equity in period 0:

$$\pi_0^T = \underbrace{-I}_{issuance\ of\ new\ equity} \tag{3.14}$$

In period 1, the project yields return from to production. Since we are considering a scenario in which the proceeds are retained instead of being distributed, taxable profit is zero in each period (i.e., dividends, purchases, and new equity issuance are all zero).

The nominal value of capital the company possesses in period 1 is given by:

$$K_1 = \underbrace{I(1-\delta)}_{real\ depreicated\ capital} \times \underbrace{(1+\theta)}_{conversion\ to\ current\ price} + \underbrace{(p+\delta)\times(1+\theta)I}_{nominal\ value\ of\ production} \tag{3.15}$$

Converting to real values (adjusting for inflation), capital can be expressed as:

$$K_1 = \underbrace{I(1-\delta)}_{real\ depreicated\ capital} + \underbrace{(p+\delta)I}_{real\ value\ of\ production} = (1+p)I \tag{3.16}$$

Similarly, for each *t*, real capital is:

$$K_t = (1+p)^t I \quad \forall t \geq 1 \tag{3.17}$$

Its nominal value is

$$K_t = ((1+p)(1+\theta))^t\, I \qquad \forall t \geq 1 \tag{3.18}$$

If the company distributes at the end of period t, the pre-tax return is:

$$V = \frac{((1+p)(1+\theta))^t}{(1+i)^t} I - I = \left(\frac{(1+p)^{\,t}}{(1+r)^t} - 1\right) I \tag{3.19}$$

The NPV value of the tax amount is:

$$T = \tau\frac{((1+p)(1+\theta))^t}{(1+i)^t} - \tau I = \tau\frac{((1+p))^t}{(1+r)^t} I - \tau I = \tau\,(\frac{(1+p)^t}{(1+r)^t} - 1) I \tag{3.20}$$

the NPV of economic returns corresponding to this scenario:

$$NPV\ of\ returns = \frac{p}{1+r} + \sum_{t=2}^{t} \frac{\left[\frac{(p+\delta)(1+\theta)}{(1+\theta)} + (1-\delta)\right]^{t-1} p}{(1+r)^t} = p\sum_{t=0}^{t}\frac{(1+p)^t}{(1+r)^{t+1}} = \frac{p(\frac{(1+p)^t}{(1+r)^t} - 1)}{p-r} \tag{3.21}$$

The AETR is the NPV of taxes divided by that of the economic returns (5.19 over 5.21):

$$AETR = \frac{T}{NPV\ of\ returns} = \frac{\tau\,(\frac{(1+p)^t}{(1+r)^t} - 1) I}{\frac{p(\frac{(1+p)^t}{(1+r)^t} - 1)}{p-r} I} = \tau\frac{(p-r)}{p} = \tau\left(1 - \frac{r}{p}\right). \tag{3.22}$$

Equations 3.4, 3.13 and 3.22 show that the AETR is similar across all the three types of cashflow tax systems: R-based, R+F based, and S-based.

3.2 A MINIMUM TAX WITH AN R-BASED CASH-FLOW SYSTEM

Proof of proposition 4.

In the R-based cash flow tax, the depreciation rate is 100 percent in the initial period, followed by a zero rate in subsequent periods. In this section, first, we assume full refundability and that refundability is in line with Pillar Two.

Tax paid in period 0 is given by:

$$T_0 = -\tau I \tag{3.23}$$

Under the GloBE rules (as described in the previous section), immediate expensing represents a timing issue [7]. Consequently, the allowance is prorated to align with standard depreciation. Therefore, the covered tax in period 0 is:

$$T_0^C = max(0, -\tau\varphi(I)) = 0 \tag{3.24}$$

The top-up tax rate is

$$\tau_{topup_0} = max(0, 15\% - 0) = 15\% \tag{3.25}$$

[7] Note that accelerated depreciation (immediate expensing) is counted as a timing difference only for tangible assets. See page 28 of OECD (2022).

The covered profit in period 0 is given by $\pi_0^c = -\varphi(I)$. Consequently, the top-up tax amount for this period is calculated as follows:

$$TPT_0 = 15\% \times max(0, -\tau\varphi(I) - SBIE_0) = 0 \qquad 3.26$$

For any given period t, where t > 0, the actual tax is determined by:

$$T_t = \tau(1+\theta)^t(p+\delta) \times (1-\delta)^{t-1}I \qquad \forall\, t > 0 \qquad 3.27$$

Correspondingly, the covered tax for these periods is expressed as:

$$T_t^C = \tau(1+\theta)^t(p+\delta)(1-\delta)^{t-1} \times I - \tau\varphi(K_t) \quad \forall\, t > 0 \qquad 3.28$$

The covered tax rate is given by the equation:

$$\frac{T_t^C}{\pi_t^c} = \frac{\tau(1+\theta)^t(p+\delta)(1-\delta)^{t-1} \times I - \tau\varphi(K_t)}{(1+\theta)^t(p+\delta)(1-\delta)^{t-1} \times I - \varphi(K_t)} = \tau \qquad 3.29$$

The resulting top-up tax rate for period t, where t > 0, is calculated as:

$$\tau_{topup_t} = ma\,x(0, 15\% - \tau) \qquad 3.30$$

Equations 3.3 to 3.30 imply that total tax paid under R-based cashflow +QDMTT is

$$T = -\tau I + \sum_{t=1}^{\infty} \tau \frac{(1+\theta)^t(p+\delta) \times (1-\delta)^{t-1}I}{(1+i)^t} + ma\,x(0, 15\% - \tau) \sum_{t=1}^{\infty} \frac{max\,(0, ((1+\theta)^t(p+\delta) \times (1-\delta)^{t-1}I - \varphi(K_t) - SBIE_t))}{(1+i)^t} \qquad 3.31$$

Equation 3.31 can be further simplified as follows:

$$T = \tau \frac{(p-r)}{r+\delta} I + ma\,x(0{,}15\% - \tau) \sum_{t=1}^{\infty} \frac{max\,(0, ((1+\theta)^t(p+\delta) \times (1-\delta)^{t-1}I - \varphi(K_t) - SBIE_t))}{(1+i)^t} \qquad 3.32$$

Denoting the covered taxable profit as:

$$\pi_t^c = (1+\theta)^t(p+\delta) \times (1-\delta)^{t-1}I - \varphi(K_t)$$

$$AETR^{R-based+QDMTT} = \tau(1 - \frac{r}{p}) + \frac{ma\,x(15\% - \tau)\sum_{t=1}^{\infty} \frac{max\,(0, (\pi_t^c - SBIE_t))}{(1+i)^t}}{\frac{p}{r+\delta}} \qquad 3.33$$

Implications

a) If $(\pi_t^c - SBIE_t) \leq 0 \;\forall\, t > 0$, a top-up tax does not apply, and the R-based cashflow tax system retains its efficiency.

Proof: If $(\pi_t^c - SBIE_t) \leq 0$, *then* $ma\,x\big(0, (\pi_t^c - SBIE_t)\big) = 0 \;\; \forall\, t > 0$. *Therefore,* $ma\,x(15\% - \tau) * max\,(0, (\pi_t^c - SBIE_t) = 0 \;\; \forall\, t > 0$. *Then,* $AETR^{R-based+QDMTT} = \tau(1 - \frac{r}{p})$

b) If $(\pi_t^c - SBIE_t) > 0 \;\; for\ at\ least\ one\ period\ t$

i. If $\tau < 15\%$:

▪ For an equity-funded investment: the R-based cash-flow tax is no longer efficient and the METR > 0. The resulting AETR is higher than in the absence of a minimum tax.

Proof: If $[\pi_t - SBIE_t] > 0$ $for\ at\ least\ one\ t\ and$ $\tau < 15\%$ *for any t, then using 3.32,*

$$T = \left\{\frac{\tau(p-r)I}{1+r}\right\} + \epsilon, where\ \ \epsilon > 0$$

The cost of capital is the economic return that will result in zero post-tax economic rent.

$\frac{\tau(\tilde{p}-r)I}{1+r} - \left\{\frac{\tau(\tilde{p}-r)I}{1+r}\right\} - \epsilon = 0$.

It is evident that $\tilde{p} > r$.

As $METR = \frac{(\tilde{p}-r)}{\tilde{p}}$*, a cost of capital* ($\tilde{p}$) *above the normal return (r) means, METR is strictly positive.*

- For a debt-funded investment: the R-based cash-flow tax remains efficient with a METR = 0 even in the top-up region. The resulting AETR is the same as in the absence of a minimum tax.

  Proof: For a debt financed project the top-up rate is max($15\% - \frac{\tau\pi_t}{\pi_t - interest\ expense}$). This is zero at a very low domestic tax rate. In addition, the top-up base is $max(0, (\pi_t - interest\ expense - SBIE_t))$. Again, this is zero for most reasonable parameters. Since the top-up tax (loss) is not refundable, the resulting METR is zero.

ii. If $\tau \geq 15\%$, the top-up tax rate is zero. Therefore, the R-based cashflow tax retains its efficiency: METR=0. Additionally, there is a similarity in the AETR between the R-based cashflow tax and the combined R-based + QDMTT systems.

4 Allowance For Corporate Equity (ACE)

Proof of proposition 5.

$$ACE\ Tax\ Base = Pretax\ Profits - \underbrace{i \times (Total\ Equity)}_{Allowance}$$

First, consider that losses are carried forward with interest or tax losses are refundable.

$$\pi_0^T = -\varphi(I) \quad 4.1$$

$$\pi_t^T = (1+\theta)^t(p+\delta) \times (1-\delta)^t I - \varphi(K_t) - \underbrace{i(K_t)}_{Allowance\ for\ equity} \quad \forall\ t > 0 \quad 4.2$$

For instance, $K_1 = ((I - \varphi(I)))$.

This formulation implies that if the depreciation for tax purposes is set at 100 percent in the initial period (indicating immediate expensing), then there would be no ACE in any subsequent period. This is because, with immediate expensing, there is no remaining asset value to calculate the allowance on.

Assuming refundability of the ACE:

$$T_0 = -\tau\varphi(I) \quad 4.3$$

$$T_t = \tau(1+\theta)^t(p+\delta) \times (1-\delta)^{t-1}I - \tau\varphi(K_t) - \tau\, i \times (K_t) \qquad \forall\, t > 0 \tag{4.4}$$

$$T = -\sum_{t=0}^{\infty} \tau \frac{\varphi(K_t)}{(1+i)^t} + \sum_{t=1}^{\infty} \tau \frac{(1+\theta)^t(p+\delta) \times (1-\delta)^{t-1}I}{(1+i)^t} - \sum_{t=1}^{\infty} \frac{\tau i \times K_t}{(1+i)^t} \tag{4.5}$$

$$T = -\tau A + \left\{\frac{\tau(p+\delta)I}{1+r}\right\} - \sum_{t=1}^{\infty} \frac{\tau i \times I}{(1+i)^t} + \sum_{t=1}^{\infty} \frac{\tau i \times \varphi(K_t)}{(1+i)^t} \tag{4.6}$$

Note that each depreciation per year is repeated ad infinitum in the expression[8] $\sum_{t=1}^{\infty} \frac{\tau i \varphi(K_t)}{(1+i)^t}$

$$T = -\tau A + \frac{\tau(p+\delta)I}{r+\delta} - \tau I + \tau A = \tau \frac{(p-r)}{r+\delta} I \tag{4.7}$$

Equation 4.7 implies that:

(1) The AETR under ACE is a function of only economic rent and the tax rate:

$$AETR = \frac{\frac{\tau(p-r)I}{1+r}}{(\frac{p}{1+r})I} = \tau\left(1 - \frac{r}{p}\right) \tag{4.8}$$

(2) When economic rent is zero, $r = p$, the expression in the bracket in 4.8, METR, is zero[9].

4.1.1 FINANCING NEUTRALITY

Suppose the project is financed with debt. Taxable income and tax payable are as follows:

$$\pi_0^T = -\varphi(I) \tag{4.9}$$

The allowance for equity in period 1 is based on the equity of the firm at the end of period 0. Using the identity that asset is equal to the sum of equity and debt, the equity at the end of period 0 is given by:

$$Asset = I - \varphi(I) = Equity + \underbrace{I}_{Debt} \Rightarrow = Equity_0 = -\varphi(I) \tag{4.10}$$

The expression for taxable income in period 1 is as follows:

$$\begin{aligned} \pi_1^T &= (1+\theta)(p+\delta)I - \varphi\big(I - \varphi(I)\big) - \underbrace{i \times I}_{interest\ on\ debt} - \underbrace{i(-\varphi(I))}_{Allowance\ for\ equity} \\ &= (1+\theta)(p+\delta)I - \varphi\big(I - \varphi(I)\big) - i(I - \varphi(I)) \end{aligned} \tag{4.11}$$

Suppose the company pays a share (α) of the principal in period 1. Equity at the end of period 1 is

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[8] Example: $\varphi(I)$ is repeated ad infinitum as follows $\sum_{t=1}^{\infty} \frac{\tau i\, \varphi(I)}{(1+i)^t} = \tau\varphi(I)$. Similarly, $\sum_{t=1}^{\infty} \frac{\tau i \varphi(I-\varphi(I))}{(1+i)^{t+1}} = \tau \frac{\varphi(I-\varphi(I))}{1+i}$. Therefore, the overall sum can be written as $\sum_{t=1}^{\infty} \frac{\tau i\, \varphi(K_t)}{(1+i)^{t-1}} = \tau A$.

[9] The user cost of capital in the literature is: $\frac{(\tilde{p}-r)}{r+\delta} - (\tau \frac{(\tilde{p}+\delta)}{r+\delta} - \tau A + \frac{\tau A}{1+i} - \tau) = 0$ which implies that $\tilde{p} = r - (r+\delta)\frac{(\tau A)i}{(1+i)(1-\tau)}$.

$$Asset = I - \varphi(I) - \varphi\big(I - \varphi(I)\big) = Equity + \underbrace{I(1-\alpha)}_{Debt} \Rightarrow = Equity_1$$
$$= -\varphi(I) - \varphi\big(I - \varphi(I)\big) + \alpha I \qquad 4.12$$

The taxable income in period 2 is given by:

$$\pi_2^T = (1+\theta)^2(p+\delta)(1-\delta)I - \varphi\Big(I - \varphi(I) - \varphi\big(I - \varphi(I)\big)\Big) - \underbrace{i \times I(1-\alpha)}_{interest\ on\ debt}$$
$$- \underbrace{i(-\varphi(I) - \varphi\big(I - \varphi(I)\big) + \alpha I)}_{Allowance\ for\ equity}$$
$$= (1+\theta)^2(p+\delta)(1-\delta)I - \varphi\Big(I - \varphi(I) - \varphi\big(I - \varphi(I)\big)\Big) \quad - i(I - \varphi(I)$$
$$- \varphi\big(I - \varphi(I)\big)) \qquad 4.13$$

Using a similar logic, the taxable income in each period t can be expressed as follows:

$$\pi_t^T = (1+\theta)^t(p+\delta) \times (1-\delta)^t I - \varphi(K_t) - \underbrace{i(K_t)}_{Allowance\ for\ equity} \qquad \forall\, t > 0 \qquad 4.14$$

It is evident that equation 6.1 and 6.9, and equation 6.2 and 6.14 are similar. That is, the tax paid is similar whether the project is financed with debt or equity, proving the neutrality of the ACE to financing source.

4.1.2 NON-REFUNDABLE ACE

If the ACE is non-refundable, the system loses its efficiency, leading to a METR that is greater than zero. The subsequent dynamics of tax liabilities is influenced by several factors including economic return (p), inflation (θ), depreciation rates (φ), and the provisions for equity allowance (i). Numerical simulations are essential to understand and predict the tax outcomes under these conditions.

The Case where ACE is carried forward but without interest leads to positive METR, but still lower than standard CIT. Specifically, depending on the economic return, depreciation, and the interest rate, the first part of 4.8 lies between:

$-\tau A + \frac{\tau(p+\delta)}{r+\delta}$ and $\tau\left(1 - \frac{r}{p}\right)$

4.2 INTRODUCING A MINIMUM TAX UNDER AN ACE

4.2.1 THE ACE AS A QRTC

Proof of proposition 6.

Under the GloBE rules, the covered taxes and the resulting top-up tax, depend significantly on whether the ACE credit is considered a qualified refundable tax credit (QRTC) or a non-qualified refundable tax credit (NQRTC).

Below, we first discuss the case where ACE is considered a QRTC. As shown in equation 2.36, QRTCs are considered covered income under GloBE. Using equation 4.7 and assuming a refundable ACE (and a QRTC) with a tax rate of τ, the covered profits in each period are denoted as follows.

For initial period t=0:

$$\pi_0^c = -\varphi(I) \qquad 4.15a$$

And for subsequent periods t>0:

$$\pi_t^c = (1+\theta)^t(p+\delta)\times(1-\delta)^{t-1}I - \varphi(K_t) + \tau\, i(K_t) \qquad \forall\, t>0 \qquad 4.15b$$

Denoting $(1+\theta)^t(p+\delta)\times(1-\delta)^{t-1}I - \varphi(K_t) = \pi_t$, the pre-credit profit, the covered tax is calculated as:

$$T_0^C = \max\big(0, -\tau\varphi(I)\big) = 0 \qquad 4.16a$$

$$T_t^C = \tau\big((1+\theta)^t(p+\delta)\times(1-\delta)^{t-1}I - \varphi(K_t)\big) = \tau\pi_t \qquad \forall\, t>0 \qquad 4.16b$$

Combing expressions 4.16a, 4.16b and the GloBE rules (equation 2.39), total tax paid under a refundable ACE + QDMTT is calculated as:

$$T = \left\{\frac{\tau(p-r)I}{1+r}\right\} + \sum_{t=1}^{\infty} max\left(0{,}15\% - \left(\frac{\tau\pi_t}{\pi_t + \tau i(K_t)}\right)\right)\frac{max\ (0, (\pi_t + \tau i(K_t) - SBIE))}{(1+i)^t} \qquad 4.17$$

$$AETR = \frac{\left\{\frac{\tau(p-r)I}{r+\delta}\right\}}{\frac{p}{r+\delta}I} + \frac{\sum_{t=1}^{\infty} max\left(0{,}15\% - \left(\frac{\tau\pi_t}{\pi_t + \tau i(K_t)}\right)\right)\frac{max\ (0, (\pi_t + \tau i(K_t) - SBIE))}{(1+i)^t}}{\frac{p}{r+\delta}I}$$

$$AETR = \tau\left(1 - \frac{r}{p}\right) + \frac{\sum_{t=1}^{\infty} max\left(0{,}15\% - \left(\frac{\tau\pi_t}{\pi_t + \tau i K_t}\right)\right)\frac{max\ (0, (\pi_t + \tau i K_t - SBIE_t))}{(1+i)^t}}{\frac{p}{r+\delta}I} \qquad 4.18$$

For instance, in period 1:

$$\frac{\tau\pi_1}{\pi_1 + \tau i(K_1)} = \frac{\tau\big((1+\theta)(p+\delta)\times I - \varphi(I-\varphi) - \varphi\big)}{\big((1+\theta)(p+\delta)I - \varphi(I-\varphi) - \varphi\big) + \tau i\big(I - \varphi(I)\big)} \qquad 4.19$$

Note that the φ is deducted from the profit in period 1 because it is carried forward (for GloBE purposes) from period 0.

Implications:

a) The threshold τ ACE QRTC below which the top-up tax rate becomes strictly positive is given by:

Proof: For the top-up rate to be zero at any given period, the GloBE ETR should be at least 15%. Hence,

$$\left(\frac{\tau\pi_t}{\pi_t + \tau i K_t}\right) \geq 15\%$$

Rearranging terms, the expression above would only be above 15%, if τ is above the threshold given by:

$$\tau^{ACEQRTC} = \frac{15\%\pi_t}{\pi_t - 15\% i K_t}$$

b) If $[\pi_t + \tau i K_t - SBIE_t] \leq 0 \; \forall$ t, no top-up tax applies ∀ τ, and the METR under the ACE is zero.

If $[\pi_t + \tau i K_t - SBIE_t] \leq 0 \; \forall$ t, then
$max\left(0,15\% - \left(\frac{\tau\pi_t}{\pi_t+\tau i K_t}\right)\right) max\left(0, (\pi_t + \tau i K_t - SBIE_t)\right) = 0 \; \forall$ t. Therefore,
$AETR = \tau\left(1 - \frac{r}{p}\right)$, cost of capital=r, and METR=0

c) If $[\pi_t + \tau i K_t - SBIE_t] > 0$ and $\tau < \tau^{ACEQRTC}$ for any t, then there is a top-up tax and the METR > 0.
Proof: If $[\pi_t + \tau i K_t - SBIE_t] > 0$ and $\tau < \tau^{ACEQRTC}$ for any t, then using 4.17,

$$T = \left\{\frac{\tau(p - r)I}{1 + r}\right\} + \in, where \;\; \in > 0$$

The cost of capital is the economic return that will result in zero post-tax economic rent.
$\frac{\tau(\tilde{p}-r)I}{1+r} - \left\{\frac{\tau(\tilde{p}-r)I}{1+r}\right\} - \in = 0$.
It is evident that $\tilde{p} > r$.
As $METR = \frac{(\tilde{p}-r)}{\tilde{p}}$, a cost of capital ($\tilde{p}$) above the normal return (r) means, METR is strictly positive.

d) Under (c) above, the top-up tax amount and hence the METR are larger than under the R-based cash-flow tax, ceteris paribus.

Proof: the top-up tax is the product of the top-up tax rate is the top-up tax base.
The top-up rate of an R-base cash flow tax is 15%-τ whereas the top-up rate of an ACE system (considered QRTC) is $15\% - \left(\frac{\tau\pi_t}{\pi_t+\tau i K_t}\right)$
$(15\% - \tau) - \left(15\% - \left(\frac{\tau\pi_t}{\pi_t+\tau i K_t}\right)\right) = -\frac{\tau^2 \tau i K_t}{\pi_t+\tau i K_t} < 0$. *Hence the top-up rate is lower under the R-based cashflow tax system.*

In addition, it is evident that the top-up base of R-based cash flow tax ($[\pi_t - SBIE_t]$) is less than the top-up base of an ACE system ($[\pi_t + \tau i K_t - SBIE_t]$).
Since both the top-up rate and top-up base of an ACE system are higher than the corresponding values of an R-based cashflow tax, the AETR and METR of an ACE (QRTC) is higher.

4.2.2 THE ACE AS A NQRTC

Proof of proposition 7.

If the ACE is treated as a NQRTC, the mechanism of refunds operates by reducing covered taxes instead of increasing covered income. In this scenario, the applicable GloBE rule is the one referenced in equation 2.39. Here, the tax credit (*X*) is calculated as ($\tau i K_t$).

To describe the dynamics of the top-up tax as it pertains to the GloBE framework under a non-refundable ACE regime, for initial period *t=0*:

$$\pi_0^c = -\varphi(I) \qquad 4.20a$$

And for subsequent periods *t > 0*:

$$\pi_t^c = (1+\theta)^t(p+\delta) \times (1-\delta)^{t-1} I - \varphi(K_t) \qquad \forall\, t > 0 \qquad 4.20b$$

Then, the covered tax is calculated as:

$$T_0^C = \max\big(0, -\tau\varphi(I)\big) = 0 \qquad 4.21a$$

$$T_t^C = \tau\big((1+\theta)^t(p+\delta) \times (1-\delta)^{t-1} I - \varphi(K_t)\big) \; - \tau i(K_t) \;\; = \;\; \tau\pi_t^c - \tau i(K_t) \qquad \forall\, t > 0 \qquad 4.22b$$

Combing expressions 4.20a to 4.20b and the GloBE rules (equation 2.39), top-up tax paid under a non-refundable ACE + QDMTT is calculated as[10]:

$$TPT = \sum_{t=1}^{\infty} max\left(0, 15\% - \tau(\frac{\pi_t^c - iK_t}{\pi_t^c})\right)\frac{max\,(0, (\pi_t^c - SBIE_t))}{(1+i)^t} \qquad 4.23$$

$$AETR\_topup = \frac{\sum_{t=1}^{\infty} max\left(0, 15\% - \tau\left(1 - \frac{iK_t}{\pi_t^c}\right)\right) \max\,(0, \frac{(\pi_t^c - SBIE_t)}{(1+i)^t})}{\frac{p}{r+\delta} I} \qquad 4.24$$

$$AETR = \tau\left(1 - \frac{r}{p}\right) + \frac{\sum_{t=1}^{\infty} max\left(0, 15\% - \tau\left(1 - \frac{iK_t}{\pi_t^c}\right)\right) \max\,(0, \frac{(\pi_t^c - SBIE_t)}{(1+i)^t})}{\frac{p}{r+\delta} I} \qquad 4.25$$

a) The threshold $\tau^{\text{ACE NQRTC}}$ below which the top-up tax rate becomes strictly positive is given by: $\tau^{\text{ACE NQRTC}} = \frac{15\%\pi_t^c}{\pi_t^c - iK_t}$, and hence $\tau^{\text{ACE NQRTC}} \geq \tau^{\text{ACE QRTC}}\ \forall$ t

Proof: The threshold tax rate is a τ *where* $15\% - \tau\left(1 - \frac{iK_t}{\pi_t^c}\right) = 0$. *Rearranging terms, it is easy to see that* $\tau^{ACE\ NQRTC} = \frac{15\%\pi_t^c}{\pi_t^c - iK_t}$

Comparing the threshold tax rates under the two scenarios:

$$\tau^{\text{ACE QRTC}} - \tau^{\text{ACE NQRTC}} = \frac{15\%\pi_t^c}{\pi_t^c - 15\% iK_t} - \frac{15\%\pi_t^c}{\pi_t - iK_t} = \frac{-12.75\%\pi_t^c}{(\pi_t^c - 15\% iK_t)(\pi_t^c - iK_t)} \leq 0$$

b) If $[\pi_t^c - SBIE_t] \leq 0\ \forall\, t$, no top-up tax applies $\forall\, \tau$.

[10] If the ACE is a NQRTC, in any *t*, the refund amount cannot be higher than the tax due based on GloBE income.

Proof: Since the top-up base is non-positive, the top-up amount would be non-positive even if the top-up tax rate is positive. Therefore, the top-up value is zero for any τ.

c) The top-up tax amount if the ACE is QRTC cannot exceed that if it is NQRTC.
Proof: There are three possibilities:
(1) $\tau > \tau^{\text{ACE NQRTC}}$. In this case, the top-up rate is zero for both systems, and the resulting METR and AETR resemble the METR and AETR without a top-up tax.
(2) $\tau^{\text{ACE QRTC}} \leq \tau \leq \tau^{\text{ACE NQRTC}}$: in this scenario, the top-up tax of an ACE that is considered a QRTC is zero, whereas the top-up tax rate of the NQRTC is positive. Hence, the AETR and METRs of the NQRTC system are higher than the QRTC.
(3) $\tau < \tau^{\text{ACE QRTC}}$: In this scenario a top-up tax applies in both systems. The increase in the top-up tax rate under the NQRTC is higher than the increase in the top-up base under the QRTC. For ease of exposition, let's consider the case of zero SBIE.

$$top - up\ of\ NQRTC - top - up\ of\ QRTC$$
$$= \left(15\% - \tau\left(\frac{\pi_t^c - iK_t}{\pi_t^c}\right)\right)(\pi_t^c) - \left(15\% - \left(\frac{\tau\pi_t}{\pi_t + \tau i(K_t)}\right)\right)\left(\pi_t + \tau i(K_t)\right)$$
$$= 85\%\tau i(K_t) > 0\ \forall\ \tau > 0$$

5 The Role of Refunding the Value of Tax Losses

5.1 IN THE ABSENCE OF A MINIMUM TAX

To highlight the implication of non-refundability, it is helpful to compare it with the baseline scenario(the case of refundable systems). In this section, we demonstrate the effect by comparing a refundable standard CIT with one in which losses are carried forward indefinitely without interest

Taxable profit under the standard CIT (refundable) for this investment in period zero is:

$$\pi_0^T = -\varphi(I). \qquad 5.1$$

Since there is no return in period 0, the taxable profit is a loss that is equivalent to the capital depreciation for tax purposes, given by the function φ. The loss is refunded in the same period. This assumption is equivalent to losses being carried forward with interest.

For each period *t* after period 0, the taxable income is denoted by:

$$\pi_t^T = (1+\theta)^t(p+\delta) \times (1-\delta)^{t-1}I - \varphi(K_t) \qquad \forall\ t > 0, \qquad 5.2$$

where π_t^T is taxable profit in period *t* before adjusting for loss carry forward from previous periods. And

$$K_0 = I, K_1 = I - \varphi(I), and\ K_2 = I - \varphi(I) - \varphi\big(I - \varphi(I)\big), \ldots$$

K_t is the tax depreciated asset at the beginning of period t. The accounting depreciation function, denoted as $\varphi(K)$, is assumed to be identical to tax depreciation.

Case 1: CIT with refundable tax losses:

If allowances for capital (depreciations) are refundable or carried forward with interest, the expressions for tax paid is:

$$T_0 = -\tau\varphi(I) \quad 5.3a$$
$$T_t = \tau(1+\theta)^t(p+\delta) \times (1-\delta)^{t-1}I - \tau\varphi(K_t) \quad \forall t > 0. \quad 5.3b$$

The NPV of the total tax, T, is then calculated as:

$$T = -\sum_{t=0}^{\infty} \tau \frac{\varphi(K_t)}{(1+i)^t} + \sum_{t=1}^{\infty} \tau \frac{(1+\theta)^t(p+\delta) \times (1-\delta)^{t-1}I}{(1+i)^t}, \quad 5.4$$

$$T = -\tau A + \frac{\tau(p+\delta)I}{r+\delta}. \quad 5.5$$

Case 2: CIT with non-refundable tax losses:

If losses are carried forward without interest and are not refundable, tax paid is determined as follows:

$$T_0 = \max\big(0, -\tau\varphi(I)\big) = 0 \quad 5.6a$$
$$T_t = \max((1+\theta)^t(p+\delta) \times (1-\delta)^{t-1}I - \varphi(K_t) - losscarry_t), \quad 5.6b$$

where $losscarry_t$ is the loss carried forward to period *t* from previous periods. For example, if loss carry forward is only from period 1.

$$T = 0 + \sum_{t=1}^{\infty} \frac{(1+\theta)^t(p+\delta) \times (1-\delta)^{t-1}I - \varphi(K_t))}{(1+i)^t} - \frac{\varphi(I)}{1+i}. \quad 5.7$$

Equation 5.5 is simplified to:

$$T = \frac{\tau(p+\delta)I}{r+\delta} - \tau A + \tau\frac{i}{1+i}\varphi(I), \quad 5.8$$

where,

$$A = \sum_{t=0}^{\infty} \frac{\varphi(K_t)}{(1+i)^t} = \tilde{A}xI$$

Comparing 5.8 and 5.5, the difference in the NPV of taxes paid under the refundability and non-refundability scenarios is:

$$T_{non-refunadable} - T_{refundable} = \tau\frac{i}{1+i}\varphi(I) \quad 5.9$$

The difference in the tax paid increases as inflation increases (since $i = r(1+\theta) + \theta$).

If tax depreciation is lower than economic depreciation ($\varphi(K) < \delta K$) , the capital stock gradually decreases to zero, and the tax depreciation becomes higher than the economic return at some period s.

$$\tau(1+\theta)^s(p+\delta) \times (1-\delta)^{s-1} I < \varphi(K_s)$$

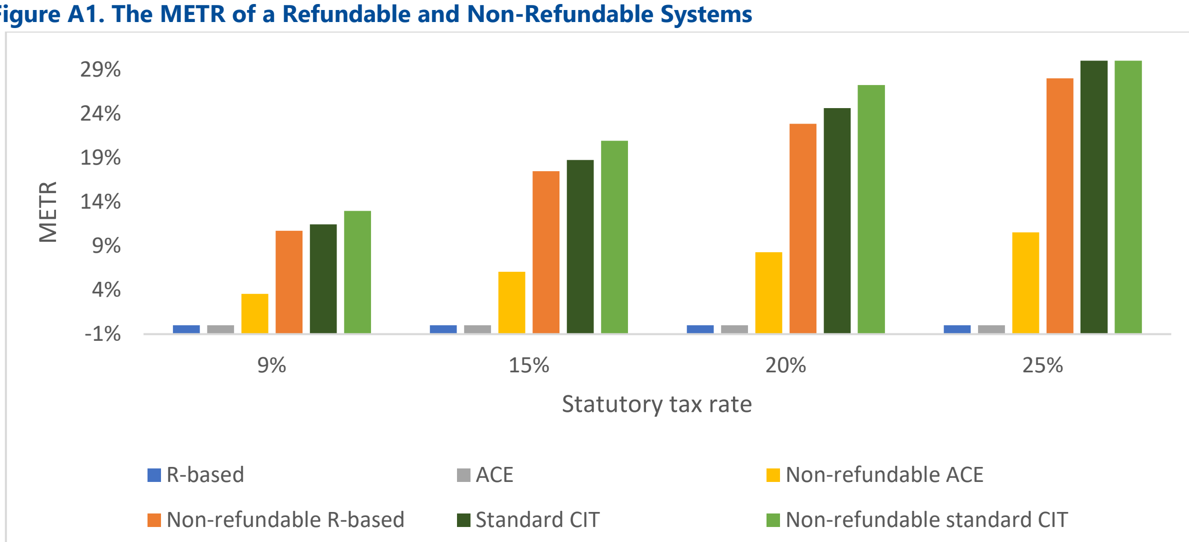
If taxes are not refundable, then these future losses would not factor in the economic rent, and the net present value of depreciation allowances decreases. As a result, the METRs and AETRs increase. Specifically,

$$A' = \sum\nolimits_{t=0}^{\infty} \frac{\varphi(K_t)}{(1+i)^t} - \sum\nolimits_{t=s}^{\infty} \frac{\varphi(K_t)}{(1+i)^t} = A - \sum\nolimits_{t=s}^{\infty} \frac{\varphi(K_t)}{(1+i)^t} \qquad 5.10$$

where s is the period in which depreciation allowance starts to become higher than economic return of the project.

Figure A1 compares the METR of refundable versus non-refundable versions of each system: standard CIT, R-based cash flow tax, and ACE. Figure A2 demonstrates that the impact of the lack of loss refunds is less significant for projects with higher profitability.

Figure A1. The METR of a Refundable and Non-Refundable Systems



Note: METR stands for the Marginal Effective Tax Rate, computed for the marginal investment that just breaks even post-tax. AETR stands for the Average Effective Tax Rate. The figure assumes an inflation rate of 5%, a real interest rate of 5%, an economic depreciation rate of 25%, and a depreciation rate for tax purposes of 25%. R-based, ACE, and Standard CIT are refundable systems, whereas the ones that start with Non-refundable are systems that do not refund the value of the tax loss.

Figure A2. The AETR of a Refundable and Non-Refundable Systems

Note: AETR stands for the Average Effective Tax Rate. The figure assumes a profitability rate of 20%, an inflation rate of 5%, a real interest rate of 5%, an economic depreciation rate of 25%, and a depreciation rate for tax purposes of 25%. R-based, ACE, and Standard CIT are refundable systems, whereas the ones that start with Non-refundable are systems that do not refund the value of the tax loss.