INTERNATIONAL MONETARY FUND

Efficient Economic Rent Taxation under a Global Minimum Corporate Tax

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WP/24/57

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IMF Working Paper
Fiscal Affairs Department

Efficient Economic Rent Taxation under a Global Minimum Corporate Tax

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Authorized for distribution by Mario Mansour
March 2024

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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.
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JEL Classification Numbers:	H21, H25, F23
Keywords:	Investment; Minimum Taxation; Corporate Tax Reform; International Taxation; Rent Tax; ACE; Effective Tax Rate

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WORKING PAPERS

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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 ones 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 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. 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 akin to the proposal by the Europen Commission (2022), known as 'Debt–Equity Bias Reduction Allowance' (DEBRA).

Despite the different design details of the two classes of efficient rent taxation models, a funda-

[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).

mental result is that both are equivalent in net present value term and achieve the same outcome of eliminating both types of aforementioned distortions.[2] We start by establishing 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 wroth 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.[3] 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

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

[3]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.

[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.

paribus. Specifically, there are three regions: (i) one where the minimum tax applies in both cases (if the statutory CIT rate is below 15 percent), 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 (if the statutory CIT rate is above 15 percent but below a threshold required for the ACE to circumvent the application of the minimum tax), 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 $= \frac{T_t^c}{\pi_t^c}$.[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. 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 income, 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 of $\pi_t^c + ACE - SBIE_t$.[9] After all, whenever the top-up binds under

[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

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

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.[10] As of February 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 QRTCs. 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.

Furthermore, we tackle the implications of relaxing the 'full loss offset' assumption altogether and provide a routine for a numerical solution of the METRs and AETRs for this case. Both the ACE and the R-based cash-flow tax lose investment efficiency and the equivalence breaks even without a top-up tax. Combining non-refundable tax losses with a top-up tax weakens the advantage of cash-flow tax to the ACE, and may even flip it around, because ACE future deductions can give a higher net present value than non-refunded immediate expensing.

There is a caveat to the (non)equivalence result. If the SBIE is very large over the entire duration of the investment[11], the top-up base is zero for all years under both systems thereby eliminating the minimum tax altogether. While this particular situation restores efficiency for both systems (under full loss offset), 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.

The findings reported here are policy relevant and can be looked at in two complementary

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.

[10]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').

[11]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.

ways to: (i) guide 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 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.[12] 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).[13] 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 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, a case can be made to instead define the top-up base as 'EBIT minus investment' (allowing carryforward) to be compatible with any efficient rent tax designs and eliminate debt bias.[14]

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

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

[13]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).

[14]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.

ACE (or a cash-flow tax).[15] The common practice has been unable to be consistent with theory 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*).[16] 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, with variants relaxing the full-refundability assumption or introducing a minimum tax similar to Pillar Two. Section 3 does the same for an R-based cash-flow 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. Finally, Section 6 concludes.

2 Standard CIT

2.1 No Minimum Tax

The starting point is a permanent investment model without taxes.[17] 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:

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

[15] Additionally, tax losses are typically not refundable. Thus, the METR for the ACE under a non-refundable CIT becomes even larger than zero. We discuss this issue in detail in Section 4.

[16] 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.

[17] The Appendix presents a step-by-step derivation of all results, and sketches a two-period model that gives similar results to those from the model presented here. 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.[18] 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 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.[19] 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:

$$AETR = \frac{T}{\frac{p}{r+\delta}I} = \tau(1+\frac{\delta}{p}) - \tau\frac{\tilde{A}}{\frac{p}{r+\delta}}. \tag{5}$$

For high levels of profitability (that is, as δ/p approaches zero and the term $\frac{p}{r+\delta}$ becomes very large), the AETR converges toward the statutory tax rate τ. The left panel of Figure 1 shows that

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

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

Figure 1: *AETRs and METRs for Equity-Funded Investment under a CIT*

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 of 25%. This figure shows that AETR and the METR are increasing in the statutory rate (given profitability) and in profitability (moving from 5% to 10% and 20%, given a statutory rate). The calculation is for a system that refunds the value of tax losses.

the AETR increases (i) as τ increases (given a profitability); or (ii) as profitability declines (given 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 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:

$$AETR = \underbrace{\frac{T}{\frac{p}{r+\delta}I} = \tau(1 + \frac{\delta}{p}) - \tau\frac{\tilde{A}}{\frac{p}{r+\delta}}}_{AETR \text{ for full equity-financing}} - \underbrace{\tau\alpha\psi i}_{\text{debt bias}}, \quad (7)$$

where $\psi > 0$ is a composite parameter.[20] Decreasing interest deductions (through lowering the share of debt α) raises the AETR. The tax benefit from debt-financing increases in τ.

Precisely, there are two elements of debt bias. First, debt receives interest deductions (the presence of the additional term $-\tau\alpha\psi i$ 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 fully debt-financed investment is even negative due excessive interest deductions beyond the normal return (left panel of Figure 2). 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 right panel of Figure 2 shows that the difference in the AETR due to the financing mode can be massive. For instance, at $\tau = 20$ percent and for the same investment, the AETR can decline from 23.1 percent (corresponding to a full equity-financing) to as low as 3.5 percent (corresponding

[20] $\psi = \frac{r+\delta}{p[i-\theta+\delta(1+\theta)]}$; see Appendix.

[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 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.

to a full debt-financing; $\alpha = 1$). Any debt-equity mix for this investment implies an AETR between these two values. The welfare implications of this 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. Before discussing these systems, it is important to complete the CIT analysis by highlighting the importance of refunding losses for efficiency, and next examine how the minimum tax affects the METRs an AETRs under the CIT.

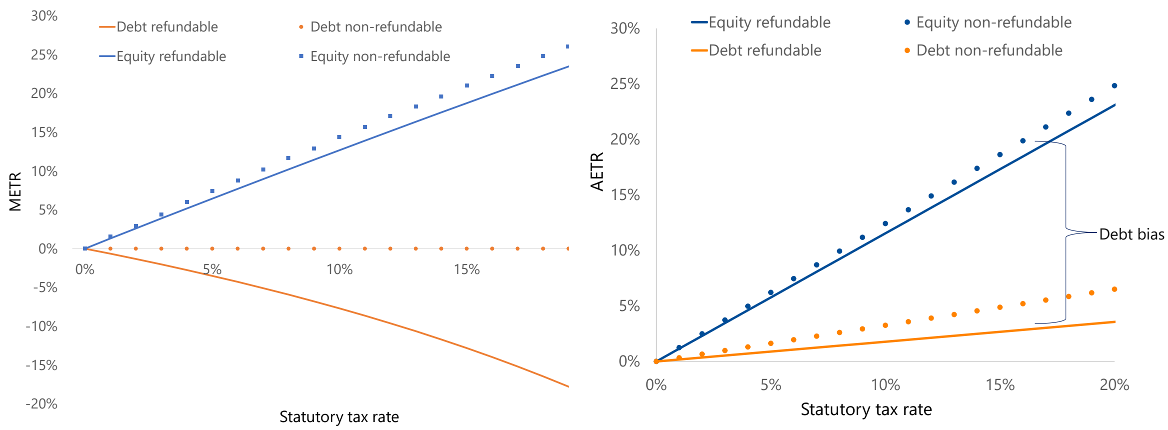
The Role of Refunding the Value of Tax Losses

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 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. Figure 2 shows that the difference can be sizable. For example, for the same investment say at $\tau = 20$ percent, and fully debt financed, the AETR increases from 3.5 percent to 6.5 percent (that is,

Figure 2: *METRs and AETRs under a CIT without Full Loss Offset*



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

Note: METR stands for the marginal effective tax rate, computed for the marginal investment that just breaks even (at a profitability of 5% in this example). 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 of 25%. In both panels, the difference between the blue and orange lines show the debt bias, and the difference between the dashed and straight lines show the impact of relaxing the assumption of full loss offset.

an increase in the AETR of almost 45 percent because of relaxing the full loss offset). The left panel shows even a biger difference in the METRs. An 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.

High inflation exacerbates the impact of incomplete loss offset on effective tax rates. The intuition is that the CIT 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.

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,

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

Second, 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, set at 5 percent of tangible assets and payroll, after a transition period. 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 the top-up tax, is given by:

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

If, 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').[23]

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

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

[23] 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.

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, 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. Pillar Two rules do not stipulate how to deal with a full loss offset (see also subsection 4.2).

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:

$$T^{Pillar2} = -\tau A + \frac{\tau(p+\delta)}{r+\delta} I + \sum_{t=1}^{\infty} \max(0, (15\% - \tau)) \frac{\max\left(0, (\pi_t^c - SBIE_t)\right)}{(1+i)^t}. \tag{10}$$

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:

$$AETR^{Pillar2} = \tau\left(1 + \frac{\delta}{p}\right) - \tau\frac{\tilde{A}}{\frac{p}{r+\delta}} + \frac{\sum_{t=1}^{\infty} \max(0, (15\% - \tau)) \frac{\max(0, (\pi_t^c - SBIE_t))}{(1+i)^t}}{\frac{p}{r+\delta}}. \tag{11}$$

The AETR under Pillar Two has a kink, determined by the cutoff $\tau = 15\%$ (Figure 3). The magnitude of the jump in the AETR in the top-up region is fully determined by the SBIE in the years of the application of the top-up tax. This jump is the highest 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, 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 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, as given in Figure 1. The following propositions summarize the key results:

Proposition 1. *Under a standard CIT and a minimum tax and a fill 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.

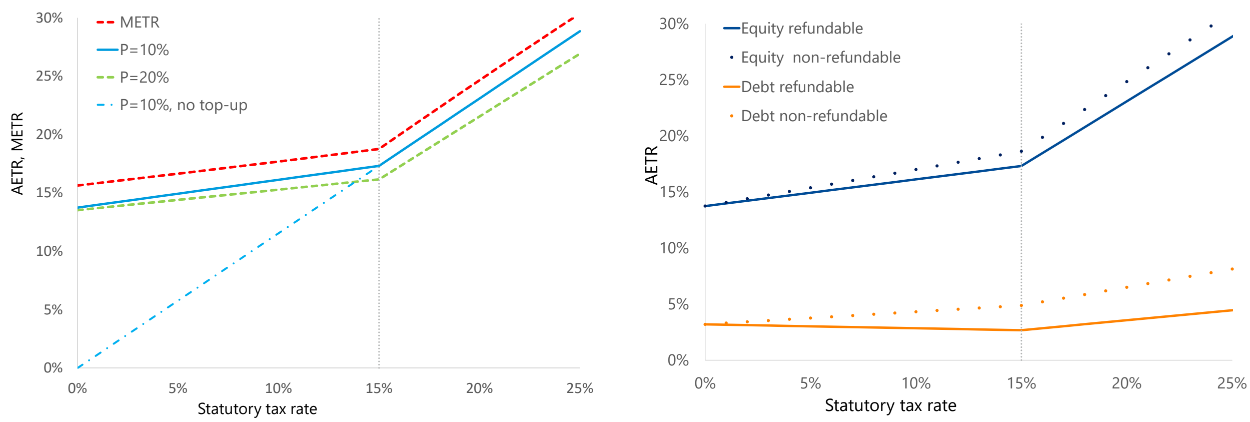
Proof. See Appendix. □

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 3: *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 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%, the assets are entirely tangibles (i.e, the lowest possible top-up tax, given payrolls) and that payrolls comprise 50 percent of tangibles (the average for US multinationals taken from the Bureau of Economic analysis). This means, in the calibration, the SBIE is 150% of tangibles. The left panel shows kinks in AETR and the METR due to the top-up tax. The right panel visualizes the increase in the AETR when the assumption of full loss offset is relaxed.

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). 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).

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 (Non)Qualified Refundable Tax credit. X is the amount of the tax credit. $SBIE$ is substance-based income exclusion.

Let X denote the amount of the tax credit so that the domestic tax is $(\tau\pi_t^c) - X_t$. The average tax payment in period t for the QRTCs and 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 these effective rates are summarized in Proposition 3 (under full loss offset).

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 they reduce the amount of the total tax. 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 in the limit as $SBIE \to \pi^c$.

Proof. See Appendix. □

To get a sense of the magnitudes, for instance, suppose a fully equity-funded investment has a pre-tax profitability of 20 percent and $\tau = 10$ percent (and hence the minimum tax is binding). For this investment the AETR is 15.3 percent (which can be read in Figure 3). If this investment is combined with a QRTC, the AETR declines to 12.3 percent, whereas if it is combined with a NQRTC the AETR only declines to 14.7 percent (not shown in 3, see the Appendix for a chart). The effect of those incentives is more pronounced for a marginal investment. For example, at $\tau = 10$ percent and no incentives, the METR is 17.7 percent. The METR significantly decreases to 6.9 percent under a QRTC, but only to 16.5 percent under a NQRTC.

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:

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

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 upper left panel of Figure 4 visualizes that the AETR for an investment with profitability of 20 percent is always higher than that with a profitability of 10 percent. However, the AETR 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).[24] On the contrary, for a standard CIT, for example with the parameterization in Figure 1 at $\tau = 15$ percent, the AETR 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 $-\tau\alpha\psi i$ 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.

[24] 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.

R-based Cash-flow Tax vs. Immediate Expensing without Refunds

As mentioned previously, under the R-based cash-flow tax losses are either immediately refunded or carried forward with interest. Failing to refund losses means that a number of periods N is needed for the losses carried forward to be absorbed. As economic return, p, increases, N decreases and for for sufficiently high p, $N = 1$. The AETR under this non-refundability scenario is:

$$AETR^{R-based,\, no\ refund} = \tau\left(1 - \frac{r}{p}\right) + \frac{1 - \frac{\sum_{t=1}^{N}(1+\theta)^t (p+\delta)\times(1-\delta)^{t-1}}{(1+i)^t}}{\frac{p}{r+\delta}}. \tag{16}$$

The marginal effective tax rate is as before:

$$METR = \frac{\tilde{p} - r}{\tilde{p}}, \tag{17}$$

but with a modified $\tilde{p}$, as given in the implicit function:

$$(1-\tau)\frac{\tilde{p} - r}{\tilde{p} + \delta} + \tau\frac{\tilde{p} + \delta}{r + \delta}\left(1 - (\frac{1-\delta}{1+r})^N\right) = 0. \tag{18}$$

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 equity-financed investment, a top-up tax can arise only if τ is below 15 percent, but not because of immediate expensing as such ($\tau_t^{topup} = 15\% - \frac{\tau\pi_t^c}{\pi_t^c} = 15\% - \tau$). However, 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 the same, irrespective of the financing.

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

$$T^{R-based,\, Pillar2} = \tau\frac{(p-r)}{r+\delta}I + \max(0, 15\% - \tau)\sum_{t=1}^{\infty}\frac{\max\left(0, (\pi_t^c - SBIE_t)\right)}{(1+i)^t}. \tag{19}$$

The AETR becomes:

$$AETR^{R-based,\, Pillar2} = \tau(1 - \frac{r}{p}) + \frac{\max(0, 15\% - \tau)\sum_{t=1}^{\infty}\frac{\max(0,\, (\pi_t^c - SBIE_t))}{(1+i)^t}}{p/(r+\delta)}. \tag{20}$$

From Equation 20, it can be readily seen that if $\tau > 15\%$, the METR remains zero METR 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)

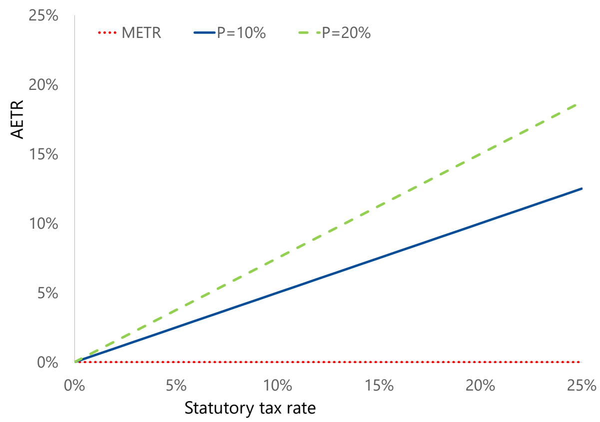
(b) If $\pi_t^c - SBIE_t > 0$ for at least one t:

- *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, and the AETRs in the R-based cash-flow tax with or without a minimum tax are identical.*

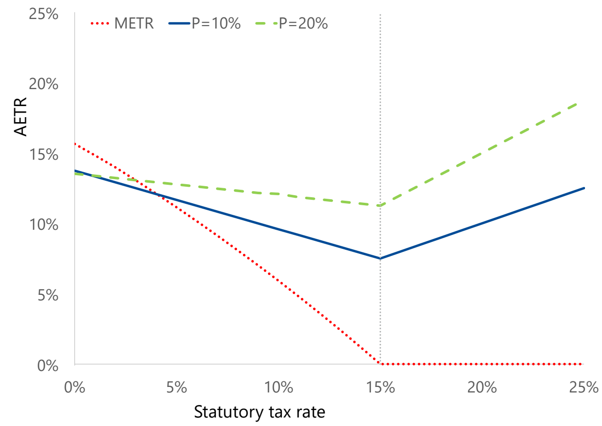
Proof. See Appendix. □

The minimum tax also 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 AETR *increases* as the statutory tax rate τ decreases if there is a top-tax (as displayed in the upper 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). The importance of this outcome to some extent depends on the investment characteristics. When the minimum tax is binding, the AETR increases as the share of intangibles in total assets increases because the SBIE declines (panel c Figure 4). However, for highly profitable investments, even if 50 percent of the assets are intangibles, comparing panels b and c in Figure 4 suggests that the difference in the AETRs is rather moderate. The difference, however, will be large especially for extreme cases, for example where the SBIE eliminates the top-up tax. Finally, panel d in 4 shows that without a refund of tax losses, the zero METR result (without a minimum tax) is abolished, and the METR and the AETR are increasing in τ, with a kink at 15 percent.

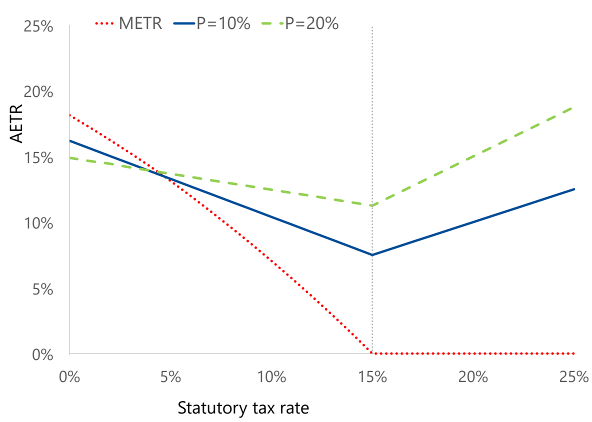
Figure 4: *AETRs under R-based Cash-Flow Tax with or without a Minimum Tax*



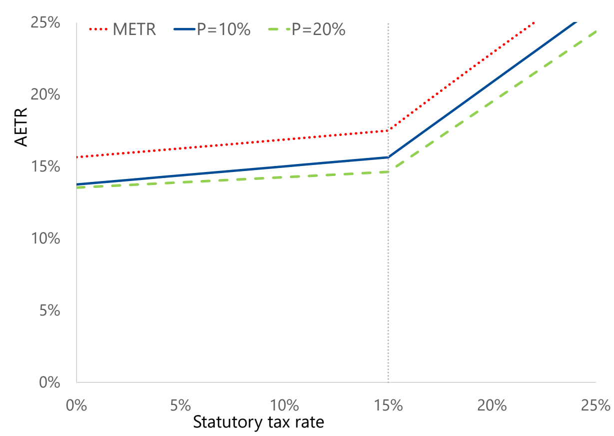
(a) *R-based Cash-Flow Tax*



(b) *R-based Cash-Flow Tax and Minimum Tax*



(c) *Assuming 50% Intangibles)*



(d) *Introducing Non-refundability of tax losses; 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%, and a depreciation rate for tax purposes of of 25%. In panels (a), (b), and (d), the assets are entirely tangibles (i.e., the lowest possible top-up tax, given payrolls) and that payrolls comprise 50 percent of tangibles (the average for US multinationals taken from the Bureau of Economic analysis). This means, in this calibration, the SBIE is 150% of tangibles. In panel (c), 50% of assets are intangibles, meaning the SBIE is 75% of tangibles. Panel (d) visualizes the increase in the METR and AETR when the full-refundability assumption of tax losses is relaxed.

4 ACE

4.1 Without a Minimum Tax

The other class of efficient rent tax models maintains efficiency by providing allowances for normal returns. It can be in the form of an allowance of corporate capital, irrespective of the financing mode (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).[25]

The ACE is neutral with respect to the tax depreciation method under full refundability (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.

To correctly evaluate an ACE regime, and establish that it is equivalent to cash-flow taxation, the specification of the equity base for the tax allowance is crucial. 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. The 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 [26]:

$$\pi_0^T = -\varphi(I) \tag{21}$$

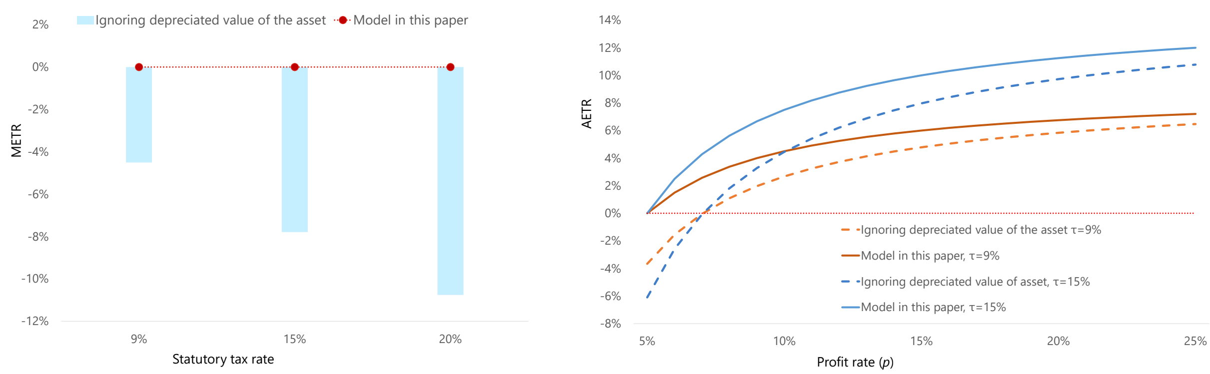
$$\pi_t^T = (1+\theta)^t (p+\delta) \times (1-\delta)^{t-1} I - \varphi(K_t) - \underbrace{i \times (K_t)}_{\text{ACE}} \qquad \forall t > 0, \tag{22}$$

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 on the entire investment I, but on

[25] 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).

[26] 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, $\pi_t^1 = (1+\theta)(p+\delta)I - \varphi(I) - \underbrace{i \times I}_{\text{interest on loan}} - (-\underbrace{i \times \varphi(I)}_{\text{ACE}}) = (1+\theta)(p+\delta)I - \varphi(I) - i \times (I - \varphi(I))$. This is equivalent to the taxable income of a project financed with retained earnings as shown in equation 22.

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.

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. □

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 $i((1+\theta)(1-\delta))^t \; \forall t \geq 0$. 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 as in the cash-flow tax, 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

Under Pillar Two rules, there are two possibilities to classify the ACE: either QRTCs or NQRTCs (discussed in Section 2.3). We know that full loss offset is needed for the efficiency of the ACE. Designing the ACE as a QRTC maintains this condition, whereas relaxing the refundability assumption classifies the ACE as NQRTC. As a NQRTC even in the absence of a binding minimum tax the ACE in inefficient. This case, however, is important because it reflects what ACE countries do: allow for carrying the ACE forward but without interest.

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

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:

$$T^{ACE+Pillar2} = \left\{ \frac{\tau(p-r)}{1+r} I \right\} + \sum_{t=1}^{\infty} \max\left(0, 15\% - \left(\frac{\tau\pi_t}{\pi_t + \tau i K_t}\right)\right) \frac{\max\left(0, \left(\pi_t + \tau i K_t - SBIE_t\right)\right)}{(1+i)^t}. \tag{23}$$

$$AETR^{ACE+Pillar2} = \tau\left(1 - \frac{r}{p}\right) + \frac{\sum_{t=1}^{\infty} \max\left(0, 15\% - \left(\frac{\tau\pi_t}{\pi_t+\tau i K_t}\right)\right) \frac{\max(0,(\pi_t+\tau i K_t - SBIE_t))}{(1+i)^t}}{\frac{p}{r+\delta} I}. \tag{24}$$

For instance, in $t = 1$:

$$\frac{\tau\pi_1}{\pi_1 + \tau i\,(K_1)} = \frac{\tau\left((1+\theta)(p+\delta)I - \varphi(I-\varphi)\right)}{\left((1+\theta)(p+\delta)I - \varphi(I-\varphi)\right) + \tau i\left(I - \varphi(I)\right)}. \tag{25}$$

Note that $\varphi(I)$ is deducted from the profit in period 1 because it is carried forward from period 0.

The key insight (from comparing Equations 19 and 23) 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. Therefore, the AETR is higher under the ACE with a top-up tax than under the cash-flow tax with the top-up. The lower the depreciation the higher the effective rate of the ACE, thereby widening this difference between both systems. Also, 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. Furthermore, the AETR increases with τ and profitability, but it has a kink as we previously seen (panel b of Figure 6). Without any top-up tax, the AETRs for both systems coincide and the METR remains zero.

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:

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

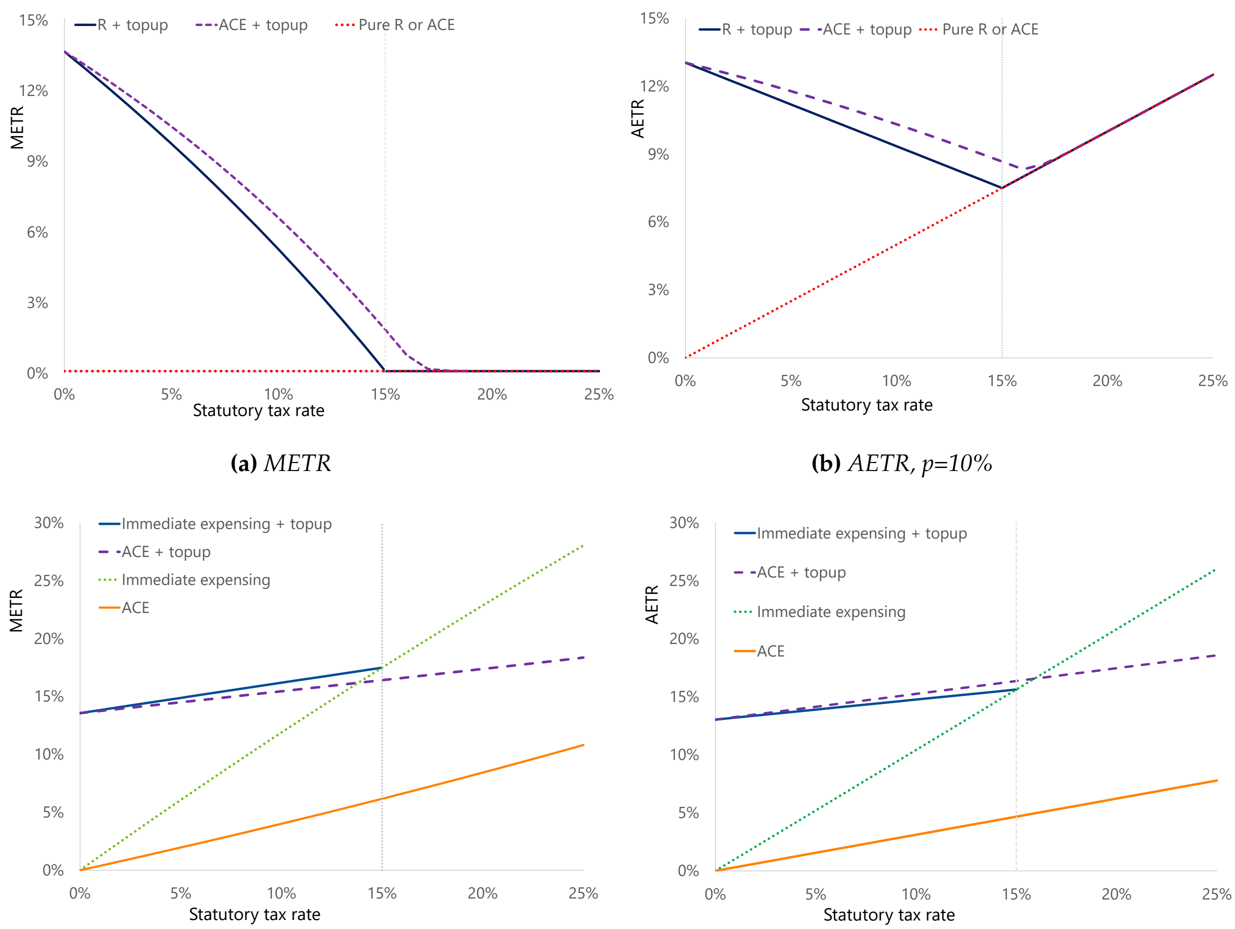
(b) If $[\pi_t^c + (\tau i K_t) - SBIE_t] \leq 0 \;\forall\, t$, no top-up tax applies $\forall\, \tau$, and the METR under the ACE is zero.

(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%*

(c) *METR* **(d)** *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 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 15%. 'Pure R or ACE' depicts the METR and AETR for before introducing a minimum tax, where 'R' is a shorthand for R-based cash-flow tax. The ACE leads to a higher METR and AETR than the R-based cash-flow tax, under a top-up tax. In the bottom panel, the figures refer to non-refundable ACE and Immediate expensing without and with a top-up tax.

The ACE as a NQRTC and a Minimum Tax

If tax loss refund is unavailable and 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: $\pi_t^c - SBIE_t$. Recall, the ACE in this case has a METR > 0, even in the absence of a minimum tax. The NPV of the total tax and the AETR for this a NQRTC ACE are, respectively:

$$T^{ACE,\,NQRTC} = \left\{\frac{\tau(p-r)}{r+\delta}\right\} I + \sum_{t=1}^{\infty} \max\left(0, 15\% - \tau\left(1 - \frac{iK_t}{\pi_t^c}\right)\right) \frac{\max(0,(\pi_t^c - SBIE_t))}{1+i}, \tag{26}$$

$$AETR^{ACE,\,NQRTC} = \tau\left(1 - \frac{r}{p}\right) + \frac{\sum_{t=1}^{\infty} \max\left(0, 15\% - \tau(1 - \frac{iK_t}{\pi_t^c})\right) \frac{\max(0,(\pi_t^c - SBIE_t))}{(1+i)^t}}{\frac{p}{r+\delta} I}. \tag{27}$$

For instance, in $t = 1$:

$$1 - \frac{iK_1}{\pi_1^c} = 1 - \frac{i\,(I - \varphi(I))}{(1+\theta)(p+\delta)I - \varphi\,(I - \varphi(I))}. \tag{28}$$

Proposition 7. *Under a minimum tax 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 $\forall\ \tau$, but the ACE remains inefficient, with METR > 0, due to the non-refundabiltiy.

(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.

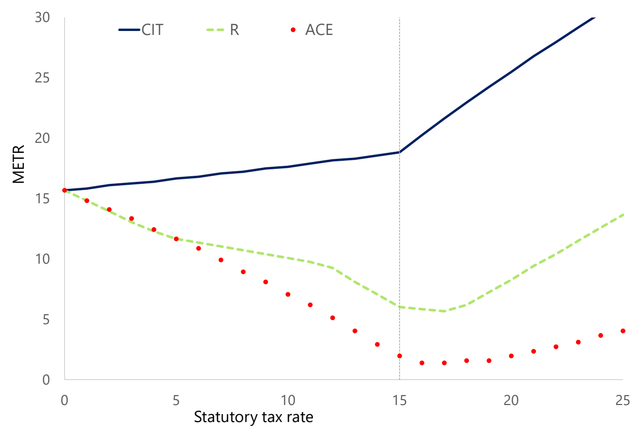
Proof. See Appendix. □

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 NQRTC, but remains higher than 15%. Part (b) in both propositions 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). This finding is summarized in part (d) of Proposition 7 and demonstrated in panel (c) of Figure 6. The chart shows that the METR for both the NQRTC ACE or cash-flow without refunds is about 15 percent at, for instance, $\tau = 5$ percent, whereas it is visibly below, at around 9 and 10 percent, in panel (a) of Figure 6.

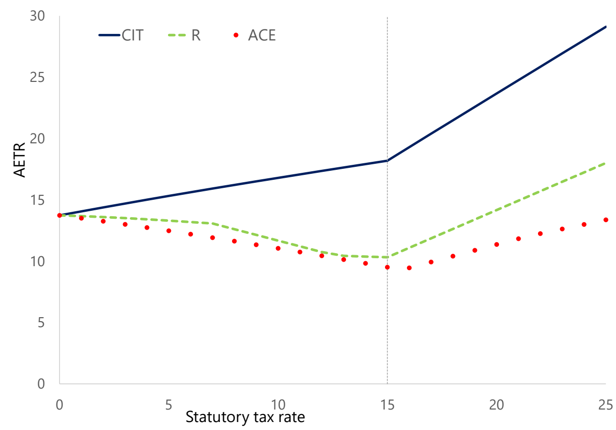
The Tax Treatment of Loses Under Pillar Two

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%, a depreciation rate for tax purposes of of 25%, the assets are entirely tangibles (i.e, the lowest possible top-up tax, given payrolls) and that payrolls comprise 50 percent of tangibles (the average for US multinationals taken from the Bureau of Economic analysis). This means, in the calibration, the SBIE is 150% of tangibles. Both panels assume that refunding the value of tax losses is considered as a qualified refundable tax credit (QRTC) under Pillar Two rules.

5 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 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. Under the ACE or cash-flow taxation, interest deductions are linked to the normal return, and therefore these systems do not generate 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 for any τ with a large QRTS. For a debt-financed investment, the amount of the credit can be lowered by combining it with debt deductions, whereas for an equity-funded investment, the relevant combination would be immediate expensing and a QRTC. However, engineering identical negative METRs irrespective of the financing mode seems to be a challenging task as the size of the credit needs to depend on the financing structure.

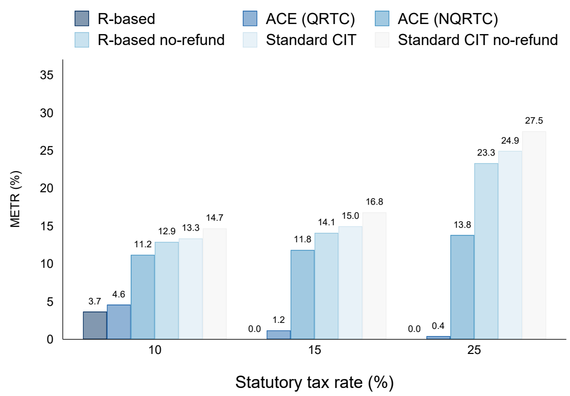
Finally, we briefly remark on the role of personal taxation in conjunction to the above profit tax designs. Under the standard CIT, high personal taxes on interest income compared to dividends and capital gains reduce corporate debt bias in the CIT, given τ; (King, 1974).[27] If equity and debt are taxed 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.

6 Conclusion

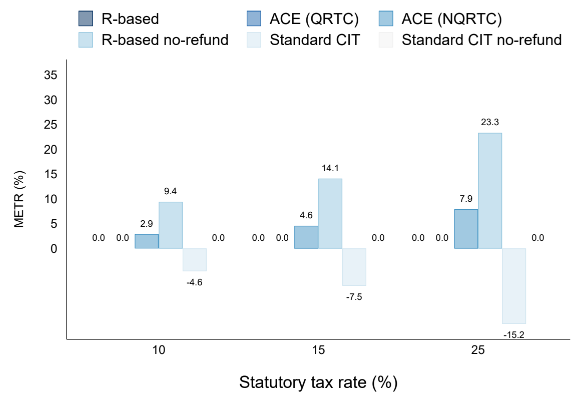
We presented a comprehensive model that encompasses a standard CIT and efficient rent tax designs with different variants, to enable a coherent comparison of the METRs and AETRs on investment under these tax systems (with and without minimum taxation). Before introducing

[27] 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*

Note: METR stands for marginal effective tax rate. Panel (a) and (b) assume an inflation rate of 2%, a real interest rate of 5%, an economic depreciation rate of 25%, and a depreciation rate for tax purposes of of 25%. 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.).

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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Working Paper No. WP/2024/057