Appendix: Forward-Looking Effective Tax Rates under the Global Minimum Corporate Tax*

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Abstract

This appendix provides supplementary material for the paper ”Forward-Looking Effective Tax Rates under the Global Minimum Corporate Tax.” It details the theoretical derivations, propositions, and methodology presented in Hebous and Mengistu (2025) and implemented in the accompanying Stata command etr and dietr, which calculate forward-looking effective tax rates consistent with the GloBE rules of the Pillar Two minimum corporate tax.

*The views expressed here are those of the authors and not necessarily those of the IMF, its Executive Board, or IMF management.

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1 Standard Corporate Income Tax

1.1 Effective Tax Rates (Two-Period Model) without Top-Up

We follow the Devereux–Griffith (DG) framework in which investment is discrete and the adoption of a project requires a fixed setup cost. At $t = 0$, the firm decides whether to undertake a project that requires a one-off investment of K_0. Conditional on adoption, this investment is sunk and fixed. The firm then produces once at $t = 1$ using variable labor only and sells the remaining asset at the end of $t = 1$. Capital is therefore not a marginal choice variable, and the investment decision is evaluated by comparing net present values.

Conditional on operation, output is produced using a constant-returns-to-scale operating technology in capital and labor. Variable inputs are chosen optimally given factor prices. The presence of the fixed setup cost implies a nonconvex project choice and allows for positive economic rent, even though the operating technology itself exhibits constant returns to scale. This distinction mirrors the cost-structure interpretation in Devereux–Griffith (2003) and the one-off investment timing in Klemm (2012).

Let the real discount rate be r, economic depreciation be $\delta \in (0, 1)$, the statutory profit tax rate be $\tau \in [0, 1)$, and the declining-balance capital-allowance parameter be $\phi \in (0, 1]$. Let p denote the real operating return per unit of capital net of economic depreciation. This return is determined after optimally choosing labor in period 1 and summarizes the optimized operating surplus generated by the project. Under the maintained assumption of constant returns in the operating technology, optimized operating surplus is linear in project scale, while the fixed setup cost governs the existence of economic rent.

Before specifying the value function, we clarify the treatment of capital gains in period 1. We assume that, instead of immediate taxation, capital gains are taxed proportionally to the remaining depreciated value of the asset.

In period 0, the firm receives a depreciation allowance equal to a fraction ϕ of the investment cost. In period 1, the share ϕ of capital gains is taxed:

$$\phi\big[(1-\delta)(1+\theta) - (1-\phi)\big].$$

In period 2, the share $\phi(1-\phi)$ is taxed, yielding:

$$\phi(1-\phi)\big[(1-\delta)(1+\theta) - (1-\phi)\big],$$

and so on.

Therefore, the nominal value function is:

$$V_{\text{DG}} = \underbrace{-K_0}_{\text{purchase}} + \underbrace{\frac{1-\tau}{1+i}\left(P_1 F(K_0, L_1) - W_1 L_1\right)}_{\text{after-tax operating}} + \underbrace{\frac{(1-\delta)(1+\theta)}{1+i}}_{\text{sale proceeds}}$$
$$- \underbrace{\sum_{t=1}^{\infty} \frac{\tau\phi(1-\phi)^{t-1}\big[(1-\delta)(1+\theta) - (1-\phi)\big]}{(1+i)^t}}_{\text{tax on capital gains}} + \underbrace{\tau\phi}_{\text{period-0 allowance}} \tag{1}$$

This expression simplifies to:

$$V_{\text{DG}} = \, -K_0 + \frac{1-\tau}{1+i}\,(P_1 F(K_0, L_1) - W_1 L_1) + \frac{(1-\delta)(1+\theta)}{1+i} - \frac{(1-\delta)(1+\theta)}{1+i}\,\tau A + \tau A \qquad (2)$$

Labor optimization pins down p.

Because capital is a fixed cost once the project is undertaken, the firm chooses labor L_1 in period 1 to maximize operating surplus:

$$P_1 F(K_0, L_1) - W_1 L_1 = P_1\{F(K_0, L_1) - \omega L_1\}, \qquad \omega \equiv W_1/P_1.$$

The first-order condition is

$$F_L(K_0, L_1) = \omega.$$

Let $L_1 = \mathcal{L}(K_0, \omega)$ denote the optimal labor choice conditional on the fixed capital stock. Substituting back yields the optimized operating surplus:

$$P_1 F(K_0, \mathcal{L}(K_0, \omega)) - W_1 \mathcal{L}(K_0, \omega).$$

Define the optimized operating return per unit of capital as:

$$\frac{P_1 F(K_0, \mathcal{L}(K_0, \omega)) - W_1 \mathcal{L}(K_0, \omega)}{K_0} \;\equiv\; P_1(p+\delta) = (1+\theta)(p+\delta).$$

The parameter p therefore summarizes the real operating return net of economic depreciation generated by the project. Importantly, p is determined by technology, demand, and factor prices, and is independent of the tax system because capital is a fixed cost and variable costs are fully deductible.

Notation. Let

$$1 + i = (1+r)(1+\theta).$$

The present value of the DB allowance stream per unit of capital is:

$$A = \sum_{t \geq 0} \frac{\phi(1-\phi)^t}{(1+i)^t} = \phi\,\frac{1+i}{i+\phi}.$$

(A) DG sale-timing (no immediate tax on gain). Substituting the optimized labor into equation 2:

$$V_{\text{DG}} = -K_0 + \frac{(1-\tau)(p+\delta)}{1+r} K_0 + \frac{1-\delta}{1+r} K_0 + \tau A K_0 - \frac{(1-\delta)\tau A}{1+r} K_0 \qquad (3)$$

Rearranging:

$$V_{\text{DG}} = \left[\frac{(1-\tau)(p+\delta)}{1+r} - \frac{(1-\tau A)(r+\delta)}{1+r}\right] K_0 \qquad (4)$$

The average effective tax rate is defined as:

$$\text{AETR} = \frac{\text{Economic rent when } \tau = 0 \ - \ \text{Economic rent when } \tau > 0}{\text{NPV of economic return}} \tag{5}$$

$$= \frac{\left[\frac{(p+\delta)}{1+r} - \frac{r+\delta}{1+r}\right] K_0 - \left[\frac{(1-\tau)(p+\delta)}{1+r} - \frac{(1-\tau A)(r+\delta)}{1+r}\right] K_0}{\frac{p}{1+r} K_0} \tag{6}$$

$$= \tau \frac{(p+\delta) - (r+\delta)A}{p} \tag{7}$$

The cost of capital is defined by the condition $\partial V_{\text{DG}}/\partial K_0 = 0$:

$$\frac{\partial V_{\text{DG}}}{\partial K_0} = 0 \quad \Rightarrow \quad \tilde{p} = \frac{(r+\delta)(1-\tau A)}{1-\tau} - \delta \tag{8}$$

(C) Debt Financing. To see the implication of debt financing, let's first find the amount of debt necessary to finance an investment of K_0 units.

The amount of debt necessary to finance this investment needs to leave the change in equity to be zero. As the impact of equity finance in period 0 is $-K_0 + \tau\phi K_0$, the borrowing needed to leave the change in equity to zero is $(1-\tau\phi)K_0$. Therefore, in period zero, borrowing is $(1-\tau\phi)K_0$. And in period 1, the firm pays principal and interest of $(1+i)(1-\tau\phi)K_0$ and gets a tax deduction of $\tau i(1-\tau\phi)K_0$.

The value function in equation 2 changes to:

$$V_{\text{DG}} = -K_0 + \frac{1-\tau}{1+i}\left(P_1 F(K_0, L_1) - W_1 L_1\right) + \frac{(1-\delta)(1+\theta)}{1+i} - \frac{(1-\delta)(1+\theta)}{1+i}\tau A + \tau A \tag{9}$$

$$+ \underbrace{(1-\tau\phi)K_0}_{\text{borrowing at } t=0} - \underbrace{\frac{(1+i)(1-\tau\phi)K_0}{1+i}}_{\text{principal + interest repaid at } t=1} + \underbrace{\frac{\tau i(1-\tau\phi)K_0}{1+i}}_{\text{interest deduction (tax shield)}} \tag{10}$$

Per K_0 and simplifying

$$V_{\text{DG}} = (1-\tau)\frac{p+\delta}{1+r} - (r+\delta)\frac{1-\tau A}{1+r} + \tau i \frac{(1-\tau\phi)}{1+i} \tag{11}$$

The cost of capital is given by setting equation 11 to zero:

$$\tilde{p} = \frac{1}{1-\tau}\left[(r+\delta)(1-\tau A) - \frac{\tau i(1-\tau\phi)}{1+\theta}\right] - \delta \tag{12}$$

$$METR = \frac{\frac{1}{1-\tau}\left[(r+\delta)(1-\tau A) - \frac{\tau i(1-\tau\phi)}{1+\theta}\right] - \delta - r}{r} \tag{13}$$

$$\text{AETR} = \tau \frac{\left[(p+\delta) - (r+\delta)A - i\,\frac{1-\tau\phi}{1+\theta}\right]}{p} \tag{14}$$

1.2 Effective Tax Rates (Two Period) with top-up (Pillar Two)

Domestic tax uses DG sale-timing (no immediate tax on sale gain); Pillar Two (GloBE) follows book (nominal) accounting, including the book gain on disposal.

Environment and notation

$$1+i = (1+r)(1+\theta), \tag{15}$$

$$A = \sum_{t\geq 0} \frac{\phi(1-\phi)^t}{(1+i)^t} = \phi\,\frac{1+i}{i+\phi}, \tag{16}$$

$$\omega \equiv \frac{W_1}{P_1} \tag{17}$$

With CRS, $F(K_0, L_1) = K_0 f(\lambda)$, $\lambda \equiv L_1/K_0$, and

$$H(\lambda) = F(K_0, L1)/K_0 - \frac{W_1}{P_1}\frac{L_1}{K_0} = F(1, \frac{L_1}{K_0}) - \omega\frac{L_1}{K_0} = f(\lambda) - \omega\,\lambda \tag{18}$$

The (real) book disposal gain is

$$\widehat{g}^{\text{G}} = \left[\frac{(1-\delta)(1+\theta)}{1+i} - \frac{1-\phi}{1+i}\right] = \frac{1}{1+r}\left[(1-\delta) - \frac{1-\phi}{1+\theta}\right] \tag{19}$$

General CRS case (no functional form)

Excess profit: The GloBE tax is based on book value. Therefore, we assume that capital gains will be taxed in the same period as it accrues. Hence, the capital gains part in period 1 is:

$(1+\theta)(1-\delta) - (1-\phi)$

Let's define the excess profit as the sum of output minus wage, plus capital gains, minus depreciation carried forward from period 0, and minus SBIE in period 1.

$$\mathcal{B}^{\mathrm{G}}(K_0, L_1) = \big[P_1 F(K_0, L_1) - W_1 L_1\big] + \big[(1+\theta)(1-\delta) - (1-\phi)\big] K_0 \\ - \big(\phi + \gamma_K\big) K_0 - \gamma_L W_1 L_1 \tag{20}$$

Excess profit per K_0

$$S^{\mathrm{G}}(\lambda) \equiv \frac{\mathcal{B}^{\mathrm{G}}}{K_0} = P_1\big[H(\lambda) - \gamma_L\,\omega\,\lambda\big] + \underbrace{\big[\theta - (1+\theta)\delta - \gamma_K\big]}_{\equiv C_G} \tag{21}$$

Value (DG timing for domestic tax; GloBE nominal)

$$V(K_0, L_1) = -K_0 + \frac{1}{1+i}\Big\{(1-\tau)\big[P_1 F - W_1 L_1\big] + (1-\delta)(1+\theta)K_0\Big\} + \tau A K_0 - \frac{1}{1+i}(1-\delta)(1+\theta)\tau A K_0 \\ - \frac{1}{1+i}\,\tau^u \max\{\mathcal{B}^{\mathrm{G}}(K_0, L_1), 0\} \;=\; K_0\,\mathcal{V}(\lambda), \tag{22}$$

$$\mathcal{V}(\lambda) = -1 + \frac{(1-\tau)P_1 H(\lambda) + (1-\delta)(1+\theta)}{1+i} + \tau A - \frac{(1-\delta)(1+\theta)\tau A}{1+i} - \frac{\tau^u \max\{S^{\mathrm{G}}(\lambda), 0\}}{1+i} \tag{23}$$

Labor choice (two regimes)

$$\text{Non-binding:} \quad f'(\lambda_{\mathrm{NB}}) = \omega, \tag{24}$$

$$\text{Binding:} \quad f'(\lambda_{\mathrm{B}}) = \left[1 - \frac{\tau^{\min} - \tau}{1 - \tau^{\min}}\,\gamma_L\right]\omega \tag{25}$$

Equation 25 shows that marginal product of labor and thus the ratio of payroll to capital depends on the domestic tax rate and the GloBE rate.

Validity:

$$S^{\mathrm{G}}(\lambda_{\mathrm{NB}}) \le 0, \qquad S^{\mathrm{G}}(\lambda_{\mathrm{B}}) > 0 \tag{26}$$

User costs (cost of capital) Suppose $S^{\mathrm{G}}(\lambda_{\mathrm{NB}}) \le 0$ Then,

$$V(1, \lambda_N B) = -1 + \frac{1}{1+r}\Big\{(1-\tau)\big[F(1, \lambda_N B) - \omega\lambda_N B\big] + (1-\delta)\Big\} + \tau A - \frac{1}{1+r}(1-\delta)\tau A \tag{27}$$

Since $\big[F(1, \lambda_N B) - \omega\lambda_N B\big] = [p + \delta]$

$$V(1, \lambda_N B) = -1 + \frac{1}{1+r}\Big\{(1-\tau)\big[p + \delta\big] + (1-\delta)\Big\} + \tau A - \frac{1}{1+r}(1-\delta)\tau A$$

(28)

Implies,

$$V(1,\lambda_N B) = \frac{1}{1+r}\Big\{(1-\tau)\big[p+\delta\big] - (r+\delta)(1-\tau A)\Big\} \tag{29}$$

Equation 29 results in the standard cost of capital equation.

$$\tilde{p}_{NB} = \frac{r+\delta}{1-\tau}(1-\tau A) - \delta \tag{30}$$

A thought experiment:

Suppose $\tau = 0$. Then equation 30 implies that the cost of capital is equal to real interest rate. $\Rightarrow \tilde{p} = r$. As mentioned above, this should fulfill the criteria that the top-up is either zero or negative. Otherwise, the FOC is derived under the wrong assumption. Assuming $\delta = \phi$

let's plug this value into $S^{\mathrm{G}}(\lambda_{\mathrm{NB}})$

$$S^{\mathrm{G}}(\lambda_{\mathrm{NB}}) = (1+\theta)[(r+\delta) - \gamma_L\omega\lambda] + \theta - (1+\theta)\delta - \gamma_k = (1+\theta)[r - \gamma_L\omega\lambda] + \theta - \gamma_k \tag{31}$$

Equation 31 shows that even at relatively low inflation rates, the top-up remains positive. Consequently, the cost of capital under the minimum tax differs from that under the domestic tax alone.

How does the cost of capital look like if the above condition ($S^{\mathrm{G}}(\lambda_{\mathrm{NB}}) \leq 0$) is not satisfied?

Assume $S^{\mathrm{G}}(\lambda) > 0$ And $\tau^u = \tau^{\min} - \tau > 0$

Note that

$$S^{\mathrm{G}}(\lambda_B) \equiv \frac{\mathcal{B}^{\mathrm{G}}}{K_0} = P_1\big[H(\lambda) - \gamma_L\,\omega\,\lambda\big] + [\theta - (1+\theta)\delta - \gamma_K] \tag{32}$$

Or

$$S^{\mathrm{G}}(\lambda_B) = \frac{\mathcal{B}^{\mathrm{G}}}{K_0} = P_1\big[p_B + \delta - \gamma_L\,\omega\,\lambda\big] + [\theta - (1+\theta)\delta - \gamma_K] \tag{33}$$

Then,

$$\mathcal{V}(\lambda) = -1 + \frac{(1-\tau)\big(p_B+\delta\big)+(1-\delta)}{1+r} + \tau A - \frac{(1-\delta)\tau A}{1+r} - \frac{1}{1+i}(\tau^{\min}-\tau)\Big\{(1+\theta)\Big[\big(p_B+\delta\big) - \gamma_L\,\omega\,\lambda\Big] + \Big[\theta-(1+\theta)\delta-\gamma_K\Big]\Big\} \tag{34}$$

Further simplifying,

$$\mathcal{V}(\lambda) = \frac{(1-\tau^{min})\big(p_B+\delta\big)-(r+\delta)(1-\tau A)}{1+r} - (\tau^{\min}-\tau)\frac{1}{1+r}\Big\{\frac{\theta}{1+\theta}-\delta-\frac{\gamma_K}{1+\theta}-\gamma_L\,\omega\,\lambda\Big\} \tag{35}$$

Equation 35 can be used to derive both AETR and METR:

To derive the cost of capital, set $\mathcal{V}(\lambda)=0$

$$\tilde{p}_B = \frac{1}{1-\tau^{\min}}\Big[(r+\delta)(1-\tau A) + (\tau^{\min}-\tau)\Big\{\frac{\theta}{1+\theta}-\delta-\frac{\gamma_K}{1+\theta}-\gamma_L\,\omega\,\lambda\Big\}\Big] - \delta \tag{36}$$

$$AETR = \frac{\tau^{min}(p_B+\delta)-(r+\delta)\tau A + (\tau^{\min}-\tau)\left[\frac{\theta}{1+\theta}-\delta-\frac{\gamma_K}{1+\theta}-\gamma_L\,\omega\,\lambda\right]}{p_B} \tag{37}$$

(B) Debt Financing. If the project was debt financed, the value function given by equation 35 changes to:

$$\mathcal{V}(\lambda) = \frac{(1-\tau^{\min})(p_B+\delta)-(r+\delta)(1-\tau A)+\tau\,\dfrac{i(1-\tau\phi)}{(1+\theta)}}{(1+r)} - (\tau^{\min}-\tau)\frac{\left\{\frac{\theta}{1+\theta}-\delta-\dfrac{i(1-\tau\phi)}{1+\theta}-\dfrac{\gamma_K}{1+\theta}-\gamma_L\,\omega\,\lambda\right\}}{1+r} \tag{38}$$

Then, the cost of capital is given by:

$$\tilde{p}_B = \frac{1}{1-\tau^{\min}}\left[(r+\delta)(1-\tau A) - \tau\,\frac{i(1-\tau\phi)}{1+\theta} + (\tau^{\min}-\tau)\left\{\frac{\theta}{1+\theta}-\delta-\frac{i(1-\tau\phi)}{1+\theta}-\frac{\gamma_K}{1+\theta}-\gamma_L\,\omega\,\lambda\right\}\right] - \delta \tag{39}$$

$$AETR = \frac{\tau^{min}(p_B+\delta) - (r+\delta)\tau A - \tau\frac{i(1-\tau\phi)}{1+\theta} + (\tau^{\min}-\tau)\left\{\frac{\theta}{1+\theta} - \delta - \frac{i(1-\tau\phi)}{1+\theta} - \frac{\gamma_K}{1+\theta} - \gamma_L\,\omega\,\lambda\right\}}{p_B} \tag{40}$$

Summary

Equity :

$$\boxed{\tilde{p}_B = \frac{1}{1-\tau^{\min}}\Big[(r+\delta)(1-\tau A) + (\tau^{\min}-\tau)\Big\{\frac{\theta}{1+\theta} - \delta - \frac{\gamma_K}{1+\theta} - \gamma_L\,\omega\,\lambda\Big\}\Big] - \delta} \tag{41}$$

$$\boxed{\text{AETR} = \frac{\tau^{\min}(p_B+\delta) - (r+\delta)\tau A + (\tau^{\min}-\tau)\left[\frac{\theta}{1+\theta} - \delta - \frac{\gamma_K}{1+\theta} - \gamma_L\,\omega\,\lambda\right]}{p_B}} \tag{42}$$

Debt :

$$\boxed{\begin{aligned}\tilde{p}_B = \frac{1}{1-\tau^{\min}}\Bigg[&(r+\delta)(1-\tau A) - \tau\,\frac{i(1-\tau\phi)}{1+\theta}\\ &+ (\tau^{\min}-\tau)\left\{\frac{\theta}{1+\theta} - \delta - \frac{i(1-\tau\phi)}{1+\theta} - \frac{\gamma_K}{1+\theta} - \gamma_L\,\omega\,\lambda\right\}\Bigg] - \delta\end{aligned}} \tag{43}$$

$$\text{AETR} = \frac{\tau^{\min}(p_B+\delta) - (r+\delta)\,\tau A - \tau\,\frac{i(1-\tau\phi)}{1+\theta} + (\tau^{\min}-\tau)\left\{\frac{\theta}{1+\theta} - \delta - \frac{i(1-\tau\phi)}{1+\theta} - \frac{\gamma_K}{1+\theta} - \gamma_L\,\omega\,\lambda\right\}}{p_B} \tag{44}$$

Notes. Equations 41-44 show that—unlike in the pre–Pillar Two case—the cost of capital under a binding top-up depends on the production function, because the term $\omega\,\lambda$ is itself determined by the technology.

In what follows, we specialize to a Cobb–Douglas production function in order to obtain closed-form expressions and to pin down a reasonable numerical magnitude.

Cobb–Douglas specialization

Technology and FOCs

$$F(K_0, L_1) = AK_0^{\beta} L_1^{1-\beta}, \qquad 0 < \beta < 1, \tag{45}$$

$$\begin{aligned} V(K_0, L_1) = -K_0 + \frac{1}{1+i}\Big\{(1-\tau)\big[P_1 F(K_0, L_1) - W_1 L_1\big] + (1-\delta)(1+\theta)K_0\Big\} + \tau A K_0 \\ - \frac{1}{1+i}(1-\delta)(1+\theta)\tau A K_0 - \frac{1}{1+i}\,\tau^u \max\{\mathcal{B}^{\mathrm{G}}(K_0, L_1), 0\}. \end{aligned} \tag{46}$$

$$\text{Non-binding (N)}: \qquad L_1^* = \left(\frac{(1-\beta)AP_1}{W_1}\right)^{\frac{1}{\beta}} K_0, \qquad P_1 Y_1^* = P_1 A \left(\frac{(1-\beta)AP_1}{W_1}\right)^{\frac{1-\beta}{\beta}} K_0, \tag{47}$$

$$W_1 L_1^* = (1-\beta)\, P_1 Y_1^*, \qquad \pi_1^{d*} = P_1 Y_1^* - W_1 L_1^* = \beta\, P_1 Y_1^*$$

Normalizing $P_0 = 1$ and recalling that $P_1 = (1+\theta)$,

$$\frac{\pi_1^{d*}}{K_0} = \beta\, P_1\, \frac{Y_1^*}{K_0} \tag{48}$$

$$= (1+\theta)\,(p+\delta), \tag{49}$$

where θ denotes the inflation rate. Therefore,

$W_1 L_1^* = (1-\beta)\, P_1 Y_1^* = (1-\beta)\frac{\pi_1^{d*}}{\beta} = \frac{(1-\beta)(1+\theta)(p+\delta)K_0}{\beta}$

Now, let's look the case of binding scenario.

Let's denote $\rho = \frac{\tau^{\min} - \tau}{1 - \tau^{\min}}$

$$\text{Binding (B)}: \qquad L_{1,B}^* = \left(\frac{(1-\beta)AP_1}{(1-\rho\gamma_L)\,W_1}\right)^{\frac{1}{\beta}} K_0, \quad P_1 Y_{1,B}^* = P_1 A \left(\frac{(1-\beta)AP_1}{(1-\rho\gamma_L)\,W_1}\right)^{\frac{1-\beta}{\beta}} K_0, \tag{50}$$

$$W_1 L_{1,B}^* = \frac{1-\beta}{1-\rho\gamma_L}\, P_1 Y_{1,B}^*, \qquad \pi_{1,B}^{d*} = P_1 Y_{1,B}^* - W_1 L_{1,B}^* = \frac{\beta - \rho\gamma_L}{1-\rho\gamma_L}\, P_1 Y_{1,B}^* \tag{51}$$

Normalizing $P_0 = 1$ and using $P_1 = (1+\theta)$, the profit–return identity becomes

$$\pi_{1,B}^{d*} = (1+\theta)\,\big(p_B + \delta\big) K_0 \tag{52}$$

Combining 51 and 52 gives a convenient formula for the (nominal) wage bill:

$$W_1 L^*_{1,B} = \frac{1-\beta}{\beta - \rho\gamma_L}\, \pi^{d*}_{1,B} = \frac{1-\beta}{\beta-\rho\gamma_L}\,(1+\theta)\,\big(p_B+\delta\big)K_0 \tag{53}$$

$$\begin{aligned}\text{Binding (B)}: \qquad V_B(K_0) = {} & -K_0 + \frac{1}{1+i}\Big\{(1-\tau)\,\pi^{d*}_{1,B} + (1-\delta)(1+\theta)K_0\Big\} + \tau A K_0 \\ & - \frac{1}{1+i}(1-\delta)(1+\theta)\tau A K_0 - \frac{1}{1+i}\,\tau^u\,\mathcal{B}^{\mathrm{G}}(K_0, L^*_{1,B}),\end{aligned} \tag{54}$$

using $\pi^{d*}_{1,B} = (1+\theta)(p_B+\delta)K_0$ and

$$\mathcal{B}^{\mathrm{G}}(K_0, L^*_{1,B}) = \Big[(1+\theta)(p_B+\delta) - \gamma_L W_1 L^*_{1,B}/K_0 + [\theta - (1+\theta)\delta - \gamma_K]\Big]K_0,$$

we obtain

$$\begin{aligned}V_B(K_0) = K_0\Bigg[& -1 + \frac{(1-\tau)(1+\theta)(p_B+\delta) + (1-\delta)(1+\theta)}{1+i} + \tau A - \frac{(1-\delta)(1+\theta)\tau A}{1+i} \\ & - \frac{\tau^u}{1+i}\Big\{(1+\theta)(p_B+\delta) - \gamma_L\frac{W_1 L^*_{1,B}}{K_0} + \theta - (1+\theta)\delta - \gamma_K\Big\}\Bigg]\end{aligned} \tag{55}$$

$$\begin{aligned}V_B(K_0) = K_0\Bigg[& -1 + \frac{(1-\tau)(1+\theta)(p_B+\delta) + (1-\delta)(1+\theta)}{1+i} + \tau A - \frac{(1-\delta)(1+\theta)\tau A}{1+i} \\ & - \frac{\tau^u}{1+i}\Big\{(1+\theta)(p_B+\delta)\Big[1-\gamma_L\,\frac{1-\beta}{\beta-\rho\gamma_L}\Big] + \big[\theta - (1+\theta)\delta - \gamma_K\big]\Big\}\Bigg],\end{aligned} \tag{56}$$

$$\text{with} \qquad \theta = \frac{\tau^{\min}-\tau}{1-\tau^{\min}}, \qquad \tau^u = \tau^{\min} - \tau$$

$$\begin{aligned}V_B(K_0) = K_0\Bigg[& -1 + \frac{(1-\tau)(p_B+\delta)}{1+r} + \frac{1-\delta}{1+r} - \frac{(1-\delta)\tau A}{1+r} + \tau A \\ & - \frac{\tau^{\min}-\tau}{1+r}\Big\{(p_B+\delta)\Big[1-\gamma_L\,\frac{1-\beta}{\beta-\rho\gamma_L}\Big] + \big[\frac{\theta}{1+\theta} - \delta - \frac{\gamma_K}{1+\theta}\big]\Big\}\Bigg]\end{aligned} \tag{57}$$

$$\begin{aligned}V_B(K_0) = {} & \frac{p_B+\delta}{1+r}\Bigg[(1-\tau) - (\tau^{\min}-\tau)\Big(1-\gamma_L\,\frac{1-\beta}{\beta-\rho\gamma_L}\Big)\Bigg] \\ & - \frac{(r+\delta)(1-\tau A)}{1+r}\end{aligned}$$

$$- \frac{\tau^{\min} - \tau}{1+r} \Big[\frac{\theta}{1+\theta} - \delta - \frac{\gamma_K}{1+\theta}\Big] K_0 \tag{58}$$

Setting $\frac{\partial V_B(K_0)}{K_0} = 0$

$$\tilde{p}_B = \frac{(r+\delta)(1-\tau A) + (\tau^{\min} - \tau)\big[\frac{\theta}{1+\theta} - \delta - \frac{\gamma_K}{1+\theta}\big]}{(1-\tau^{\min}) + (\tau^{\min} - \tau)\Big(\gamma_L \frac{1-\beta}{\beta - \rho\gamma_L}\Big)} - \delta \tag{59}$$

We can also use equation 58 to generate the AETR as follows:

$$AETR = \frac{1}{p_B}\left((p_B + \delta)\Big[\tau^{min} - (\tau^{\min} - \tau)\, \frac{\gamma_L(1-\beta)}{\beta - \rho\gamma_L}\Big] - (r+\delta)\tau A + (\tau^{\min} - \tau)\left[\frac{\theta}{1+\theta} - \delta - \frac{\gamma_K}{1+\theta}\right]\right) \tag{60}$$

The equivalent cost of capital and AETR equations of a debt financed project, under Cobb-Douglas, if the top-up is binding:

$$\tilde{p}_B = \frac{(r+\delta)(1-\tau A) - \tau\frac{i(1-\tau\phi)}{1+\theta} + (\tau^{\min} - \tau)\left[\frac{\theta}{1+\theta} - \delta - \frac{i(1-\tau\phi)}{1+\theta} - \frac{\gamma_K}{1+\theta}\right]}{(1-\tau^{\min}) + (\tau^{\min} - \tau)\Big(\gamma_L \frac{1-\beta}{\beta - \rho\gamma_L}\Big)} - \delta \tag{61}$$

$$\begin{aligned} AETR = \frac{1}{p_B}\Bigg(& (p_B + \delta)\Big[\tau^{min} - (\tau^{\min} - \tau)\, \frac{\gamma_L(1-\beta)}{\beta - \rho\gamma_L}\Big] - (r+\delta)\tau A - \tau\frac{i(1-\tau\phi)}{1+\theta} \\ & + (\tau^{\min} - \tau)\left[\frac{\theta}{1+\theta} - \delta - \frac{i(1-\tau\phi)}{1+\theta} - \frac{\gamma_K}{1+\theta}\right]\Bigg) \end{aligned} \tag{62}$$

1.3 Minimum tax with two periods (with qualified refundable tax credit)

Domestic tax uses DG sale-timing (no immediate tax on sale gain); Pillar Two (GloBE) follows book (nominal) accounting, including the book gain on disposal. A qualified refundable tax credit (QRTC) of size μK_0 affects the GloBE top-up as specified below and also enters the value function as a period-1 inflow.

Definitions

$$X(K_0, L_1) \equiv P_1 F(K_0, L_1) - W_1 L_1 + [\theta - (1+\theta)\delta]K_0, \qquad D(K_0, L_1) \equiv X(K_0, L_1) + \mu\, K_0, \tag{63}$$

$$\tau_\mu^u(K_0, L_1) \equiv \tau^{\min} - \tau\,\frac{X(K_0, L_1)}{D(K_0, L_1)} \tag{64}$$

$$1 + i = (1 + r)(1 + \theta), \tag{65}$$

$$A = \sum_{t \geq 0} \frac{\phi(1 - \phi)^t}{(1 + i)^t} = \phi\,\frac{1 + i}{i + \phi}, \tag{66}$$

$$\omega \equiv \frac{W_1}{P_1}, \tag{67}$$

$$\text{CRS:} \quad F(K_0, L_1) = K_0\, f(\lambda), \qquad \lambda \equiv \frac{L_1}{K_0}, \tag{68}$$

$$H(\lambda) = F\Big(\frac{K_0}{K_0}, \frac{L_1}{K_0}\Big) - \frac{W_1}{P_1}\frac{L_1}{K_0} = F\Big(1, \frac{L_1}{K_0}\Big) - \frac{W_1}{P_1}\frac{L_1}{K_0} = f(\lambda) - \omega\,\lambda, \tag{69}$$

$$S^{\mathrm{G},\mu}(\lambda) \equiv \frac{\mathcal{B}^{\mathrm{G},\mu}}{K_0} = P_1[H(\lambda) - \gamma_L\,\omega\,\lambda] + \Big[\theta - (1 + \theta)\delta - \gamma_K + \mu\Big], \tag{70}$$

$$x(\lambda) \equiv P_1\, H(\lambda) + [\theta - (1 + \theta)\delta], \qquad d(\lambda) \equiv x(\lambda) + \mu, \tag{71}$$

$$\Theta(\lambda) \equiv \tau^{\min} - \tau\,\frac{x(\lambda)}{d(\lambda)} \tag{72}$$

Note that μ may vary with the tax rate, as in the case of an ACE, or it may be independent of the tax rate. In either case, the definitions of $x(\lambda)$ and $d(\lambda)$ remain unchanged.

Nominal GloBE base and top-up with QRTC

Nominal GloBE base (levels)

$$\mathcal{B}^{\mathrm{G},\mu}(K_0, L_1) = \big[P_1 F(K_0, L_1) - W_1 L_1\big] + \Big[\theta - (1 + \theta)\delta - \gamma_K\Big] K_0 - \gamma_L\, W_1 L_1 + \mu\, K_0 \tag{73}$$

Per-unit base and top-up rate. Recall $S^{\mathrm{G},\mu}(\lambda)$ from Equation 70 and $\Theta(\lambda)$ from Equation 72. The top-up amount (per unit) is

$$\text{Top-up per unit} = \Theta(\lambda) \cdot \max\big\{S^{\mathrm{G},\mu}(\lambda),\, 0\big\} \tag{74}$$

Value function

At $t = 0$,

$$V(K_0, L_1) = -K_0 + \frac{1}{1 + i}\Big\{(1 - \tau)\big[P_1 F(K_0, L_1) - W_1 L_1\big] + (1 - \delta)(1 + \theta) K_0\Big\} + \tau A K_0 - \frac{(1 - \delta)(1 + \theta)\,\tau A}{1 + i}\, K_0$$
$$+ \frac{\mu}{1 + i}\, K_0 - \frac{1}{1 + i}\,\Theta(\lambda)\,\max\big\{\mathcal{B}^{\mathrm{G},\mu}(K_0, L_1),\, 0\big\} \tag{75}$$

Per unit of K_0, writing $V(K_0, L_1) = K_0\,\mathcal{V}(\lambda)$ and recalling $S^{\mathrm{G},\mu}(\lambda)$,

$$\mathcal{V}(\lambda) = -1 + \frac{(1-\tau)\,P_1 H(\lambda) + (1-\delta)(1+\theta)}{1+i} + \tau A - \frac{(1-\delta)(1+\theta)\,\tau A}{1+i} + \frac{\mu}{1+i} - \frac{\Theta(\lambda)\,\max\{S^{\mathrm{G},\mu}(\lambda), 0\}}{1+i} \tag{76}$$

Derivatives and binding FOC (levels)

Recall $\mathcal{B}^{\mathrm{G},\mu}(K_0, L_1)$ from equation 73. Then

$$\frac{\partial X}{\partial L_1} = P_1 F_L(K_0, L_1) - W_1, \qquad \frac{\partial \mathcal{B}^{\mathrm{G},\mu}}{\partial L_1} = P_1 F_L(K_0, L_1) - W_1 - \gamma_L\,W_1, \tag{77}$$

$$\frac{\partial}{\partial L_1}\left(\frac{X}{D}\right) = \frac{\mu\,K_0\big(P_1 F_L(K_0, L_1) - W_1\big)}{D(K_0, L_1)^2}, \qquad \Rightarrow \quad \frac{\partial \tau^u_\mu}{\partial L_1} = -\,\tau\,\frac{\mu\,K_0\big(P_1 F_L - W_1\big)}{D^2} \tag{78}$$

Binding FOC (levels). When the top-up binds (i.e., $\mathcal{B}^{\mathrm{G},\mu} > 0$),

$$0 = (1-\tau)\big(P_1 F_L - W_1\big) \;-\; \Bigg[\underbrace{\frac{\partial \tau^u_\mu}{\partial L_1}}_{-\,\tau\,\frac{\mu\,K_0(P_1 F_L - W_1)}{D^2}} \mathcal{B}^{\mathrm{G},\mu} \;+\; \tau^u_\mu \underbrace{\frac{\partial \mathcal{B}^{\mathrm{G},\mu}}{\partial L_1}}_{P_1 F_L - W_1 - \gamma_L\,W_1}\Bigg] \tag{79}$$

$$\iff (1-\tau)(P_1 F_L - W_1) \;+\; \tau\,\frac{\mu\,K_0(P_1 F_L - W_1)}{D^2}\,\mathcal{B}^{\mathrm{G},\mu} \;-\; \Big(\tau^{\min} - \tau\,\tfrac{X}{D}\Big)\,\big(P_1 F_L - W_1 - \gamma_L\,W_1\big) = 0$$

When the top-up does not bind (i.e., $\mathcal{B}^{\mathrm{G},\mu} \le 0$),

$$0 = (1-\tau)\big(P_1 F_L - W_1\big) = 0 \qquad \iff \; F_L = \frac{W_1}{P_1} \tag{80}$$

Optimal labor (per unit)

Non-binding top-up. If $S^{\mathrm{G},\mu}(\lambda^*) \le 0$, then

$$H'(\lambda^*) = 0 \quad \iff \quad f'(\lambda^*) = \omega \tag{81}$$

Binding top-up. If $S^{\mathrm{G},\mu}(\lambda^*) > 0$, recalling $\Theta(\lambda)$ and $d(\lambda)$ from equations 71 –72, the FOC (per unit) can be written as

$$(1-\tau)\,P_1 H'(\lambda) \;+\; \tau\,\frac{\mu\,P_1 H'(\lambda)}{d(\lambda)^2}\,S^{\mathrm{G},\mu}(\lambda) \;-\; \Theta(\lambda)\,P_1\big[H'(\lambda) - \gamma_L\,\omega\big] = 0, \tag{82}$$

which implies

$$H'(\lambda^{\mathrm{B}}) = -\frac{\Theta(\lambda^{\mathrm{B}})\,\gamma_L\,\omega}{(1-\tau) - \Theta(\lambda^{\mathrm{B}}) + \dfrac{\tau\,\mu}{d(\lambda^{\mathrm{B}})^2}\,S^{\mathrm{G},\mu}(\lambda^{\mathrm{B}})}, \tag{83}$$

$$\begin{aligned} f'(\lambda^{\mathrm{B}}) &= \omega\left[1 - \frac{\Theta(\lambda^{\mathrm{B}})\,\gamma_L}{(1-\tau) - \Theta(\lambda^{\mathrm{B}}) + \dfrac{\tau\,\mu}{d(\lambda^{\mathrm{B}})^2}\,S^{\mathrm{G},\mu}(\lambda^{\mathrm{B}})}\right] \\ &= \omega\left[1 - \frac{\left(\tau^{min} - \tau\frac{x(\lambda)}{x(\lambda)+\mu}\right)\gamma_L}{(1-\tau) - \left(\tau^{min} - \tau\frac{x(\lambda)}{x(\lambda)+\mu)}\right) + \dfrac{\tau\,\mu}{d(\lambda^{\mathrm{B}})^2}\,S^{\mathrm{G},\mu}(\lambda^{\mathrm{B}})}\right] \\ &= \omega\left[1 - \frac{\left(\tau^{min} - \tau\frac{x(\lambda)}{x(\lambda)+\mu}\right)\gamma_L}{(1-\tau) - \left(\tau^{min} - \tau\frac{x(\lambda)}{x(\lambda)+\mu)}\right) + \dfrac{\tau\,\mu}{x(\lambda)+\mu} - \dfrac{\tau\,\mu}{(x(\lambda)+\mu)^2}\left[\gamma_K(1-\phi) + \gamma_L\omega\lambda(1+\theta)\right]}\right] \end{aligned} \tag{84}$$

Note that, in the absence of a QRTC, the above will collapse into:

$$f'(\lambda^{\mathrm{B}}) = \omega\left[1 - \frac{(\tau^{min} - \tau)}{(1-\tau) - (\tau^{min} - \tau)}\gamma_L\right] = \omega\left[1 - \frac{\tau^{min} - \tau}{1 - \tau^{min}}\gamma_L\right] \tag{85}$$

Which is the same condition we have established in the previous section.

Cost of capital, at λ^*

Using $(1+i) - (1-\delta)(1+\theta) = (1+\theta)(r+\delta)$ and setting $\mathcal{V}(\lambda^*) = 0$:

Non-binding top-up ($S^{\mathrm{G},\mu}(\lambda^{\mathrm{N}}) \leq 0$)

$$\mathcal{V}(\lambda) = -1 + \frac{(1-\tau)\,(1+\theta)H(\lambda) + (1-\delta)(1+\theta)}{1+i} + \tau A - \frac{(1-\delta)(1+\theta)\,\tau A}{1+i} + \frac{\mu}{1+i} = 0 \tag{86}$$

Simplifying,

$$\mathcal{V}(\lambda) = \frac{(1-\tau)\,(\tilde{p}_N + \delta)}{1+r} - \frac{(r+\delta)(1-\tau A)}{1+r} + \frac{\mu}{1+i} = 0 \tag{87}$$

$$\tilde{p}^{\mathrm{N}} = \frac{(r+\delta)\,(1-\tau A)\; - \;\dfrac{\mu}{1+\theta}}{1-\tau} - \delta \tag{88}$$

We will show later in the ACE section that under ACE, $\mu = \tau(1+\theta)(r+\delta)(1-A)$

Binding top-up ($S^{\mathrm{G},\mu}(\lambda^{\mathrm{B}}) > 0$)

$$\mathcal{V}(\lambda) = -1 + \frac{(1-\tau)\,P_1 H(\lambda) + (1-\delta)(1+\theta)}{1+i} + \tau A - \frac{(1-\delta)(1+\theta)\,\tau A}{1+i} + \frac{\mu}{1+i} - \frac{\Theta(\lambda)\ \max\{S^{\mathrm{G},\mu}(\lambda), 0\}}{1+i} \tag{89}$$

$$\mathcal{V}(\lambda) = -1 + \frac{(1-\tau)\,(1+\theta)(p_B+\delta) + (1-\delta)(1+\theta)}{1+i} + \tau A - \frac{(1-\delta)(1+\theta)\,\tau A}{1+i} + \frac{\mu}{1+i} - \frac{\Theta(\lambda)\ \max\{S^{\mathrm{G},\mu}(\lambda), 0\}}{1+i} \tag{90}$$

let's denote $\dfrac{(1+\theta)(p_B+\delta) + \theta - (1+\theta)\delta}{(1+\theta)(p_B+\delta) + \theta - (1+\theta)\delta + \mu} = \xi^{\mu}$

Then,

$$\begin{aligned} \mathcal{V}(\lambda) = {} & -1 + \tau A + \frac{(1-\tau)(1+\theta)(p_B+\delta) + (1-\delta)(1+\theta) - (1-\delta)(1+\theta)\tau A + \mu}{1+i} \\ & - \frac{\Big(\tau^{\min} - \tau\,\xi^{\mu}\Big)}{1+i} \\ & \times \max\Big\{0,\ (1+\theta)(p_B+\delta) + \big[\mu + \theta - (1+\theta)\delta - \gamma_K\big] - \gamma_L\, W_1 \lambda_B\Big\} \end{aligned} \tag{91}$$

$$\begin{aligned} \mathcal{V}(\lambda) = {} & \frac{(1-\tau)\,(p_B+\delta)}{1+r} - \frac{r+\delta}{1+r}(1-\tau A) + \frac{\mu}{1+i} \\ & - \Big(\tau^{\min} - \tau\,\xi^{\mu}\Big) \frac{\max\Big\{0,\ (p_B+\delta) + \big[\frac{\mu}{1+\theta} + \frac{\theta}{1+\theta} - \delta - \frac{\gamma_K}{1+\theta}\big] - \gamma_L\,\omega\lambda_B\Big\}}{1+r} \end{aligned}$$

$$\begin{aligned} \mathcal{V}(\lambda) = {} & \frac{[1 - \tau - (\tau^{min} - \tau\xi^{\mu})]\,(p_B+\delta)}{1+r} - \frac{(r+\delta)(1-\tau A)}{1+r} + \frac{\mu}{1+i} \\ & - \frac{\Big(\tau^{\min} - \tau\xi^{\mu}\Big)\ \Big\{\frac{\mu}{1+\theta} + \frac{\theta}{1+\theta} - \delta - \frac{\gamma_K}{1+\theta} - \gamma_L\,\omega\,\lambda_B\Big\}}{1+r} \end{aligned} \tag{92}$$

We can use equation 92 to derive the Cost of capital, METR, and AETR as follows:

To find the cost of capital, set the value to zero.

$$\begin{aligned} \tilde{p}_B = {} & \frac{1}{1 - \tau - \big(\tau^{\min} - \tau\,\xi^{\mu}\big)} \Bigg[(r+\delta)(1-\tau A) - \frac{\mu}{1+\theta} \\ & + \big(\tau^{\min} - \tau\,\xi^{\mu}\big)\left(\frac{\mu}{1+\theta} + \frac{\theta}{1+\theta} - \delta - \frac{\gamma_K}{1+\theta} - \gamma_L\,\omega\,\lambda_B\right)\Bigg] - \delta \end{aligned} \tag{93}$$

Note that since ξ^{μ} is also a function of $\tilde{p}_B$, equation 93 is non-linear and can only be solved numerically.

The AETR:

$$\text{AETR} = \frac{p_B - r - \left(1 - \tau - (\tau^{\min} - \tau\xi^{\mu})\right)(p_B + \delta) + (r + \delta)(1 - \tau A) - \frac{\mu}{1+\theta}}{p_B} + \frac{\left(\tau^{\min} - \tau\xi^{\mu}\right)\left\{\frac{\mu}{1+\theta} + \frac{\theta}{1+\theta} - \delta - \frac{\gamma_K}{1+\theta} - \gamma_L\,\omega\,\lambda_B\right\}}{p_B} \tag{94}$$

Further simplifying,

$$\text{AETR} = \frac{[\tau + (\tau^{\min} - \tau\xi^{\mu})](p_B + \delta) - (r + \delta)\tau A - \frac{\mu}{1+\theta}}{p_B} + \frac{\left(\tau^{\min} - \tau\xi^{\mu}\right)\left\{\frac{\mu}{1+\theta} + \frac{\theta}{1+\theta} - \delta - \frac{\gamma_K}{1+\theta} - \gamma_L\,\omega\,\lambda_B\right\}}{p_B} \tag{95}$$

1.3.1 Cobb–Douglas + QRTC: pinning down $\omega L_1/K_0$

Non-binding top-up (QRTC present but not binding). With no binding, the FOC is the usual $P_1 F_L = W_1$. Using $F_L = (1-\beta)AK_0^{\beta}L_1^{-\beta}$ and $\pi_1^{d*} = (1+\theta)(p+\delta)K_0$,

$$\boxed{\omega\,\frac{L_1^*}{K_0} = \frac{W_1 L_1^*}{P_1 K_0} = \frac{1-\beta}{\beta}\,(p+\delta)}$$

(Identical to the no-QRTC case: μ does not affect the non-binding labor FOC.)

Binding top-up with QRTC. From our QRTC FOC (per unit),

$$f'(\lambda) = \omega\left[1 - \frac{\left(\tau^{min} - \tau\frac{x(\lambda)}{x(\lambda)+\mu}\right)\gamma_L}{(1-\tau) - \left(\tau^{min} - \tau\frac{x(\lambda)}{x(\lambda)+\mu}\right) + \frac{\tau\,\mu}{(x(\lambda)+\mu)} - \frac{\tau\,\mu}{(x(\lambda)+\mu)^2}\left[\gamma_K + \gamma_L\omega\lambda(1+\theta)\right]}\right] \tag{96}$$

Since $f = A\lambda^{1-\beta}$, $f'(\lambda) = (1-\beta)A\lambda^{-\beta}$

Then, multiplying equation 96 by λ and denoting $\omega\lambda$ by Z, we get:

$$(1-\beta)A\lambda^{1-\beta} = Z\left[1 - \frac{\left(\tau^{min} - \tau\frac{x(\lambda)}{x(\lambda)+\mu}\right)\gamma_L}{(1-\tau) - \left(\tau^{min} - \tau\frac{x(\lambda)}{x(\lambda)+\mu}\right) + \frac{\tau\,\mu}{(x(\lambda)+\mu)} - \frac{\tau\,\mu}{(x(\lambda)+\mu)^2}\left[\gamma_K + \gamma_L\omega\lambda(1+\theta)\right]}\right] \tag{97}$$

Also note that in equibirum, $f(\lambda) - \omega\lambda = P_B + \delta$. Therefore, $A\lambda^{1-\beta} - Z = P_B + \delta$ or $A\lambda^{1-\beta} = Z + P_B + \delta$

We can use these notations and equation 144 to express the equilibrium condition as a function of Z.

$$(1-\beta)(Z + P_B + \delta) = Z \left[1 - \frac{\left(\tau^{\min} - \tau \frac{x(\lambda)}{x(\lambda)+\mu}\right)\gamma_L}{(1-\tau) - \left(\tau^{\min} - \tau \frac{x(\lambda)}{x(\lambda)+\mu}\right) + \frac{\tau\,\mu}{x(\lambda)+\mu} \\ - \frac{\tau\,\mu}{\left(x(\lambda)+\mu\right)^2}\left[\gamma_K + \gamma_L Z(1+\theta)\right]} \right] \tag{98}$$

Which can be simplified to:

$$(1-\beta)(P_B + \delta) = Z \left[\beta - \frac{\left(\tau^{min} - \tau\frac{x(\lambda)}{x(\lambda)+\mu}\right)\gamma_L}{(1-\tau) - \left(\tau^{min} - \tau\frac{x(\lambda)}{x(\lambda)+\mu)}\right) + \frac{\tau\,\mu}{(x(\lambda)+\mu)} - \frac{\tau\,\mu}{(x(\lambda)+\mu)^2}\Big[\gamma_K + \gamma_L Z(1+\theta)\Big]} \right] \tag{99}$$

Collecting similar terms:

$$\begin{aligned}
&(1-\beta)(P_B+\delta)\left[(1-\tau) - \left(\tau^{\min} - \tau\,\frac{x(\lambda)}{x(\lambda)+\mu}\right) + \frac{\tau\,\mu}{(x(\lambda)+\mu)} - \frac{\tau\,\mu}{\left(x(\lambda)+\mu\right)^2}\gamma_K\right] \\
&\quad - (1-\beta)(P_B+\delta)\frac{\tau\,\mu}{\left(x(\lambda)+\mu\right)^2}\gamma_L\,Z(1+\theta) \\
&\quad = Z\left[\beta\left((1-\tau) - (\tau^{\min} - \tau\,\frac{x(\lambda)}{x(\lambda)+\mu}) + \frac{\tau\,\mu}{(x(\lambda)+\mu)} - \frac{\tau\,\mu}{\left(x(\lambda)+\mu\right)^2}\Big[\gamma_K + \gamma_L\,Z(1+\theta)\Big]\right)\right. \\
&\quad\left. - \left(\tau^{\min} - \tau\,\frac{x(\lambda)}{x(\lambda)+\mu}\right)\gamma_L\right]
\end{aligned} \tag{100}$$

Rewriting (100) as a quadratic in $Z = \omega\lambda$:

$$\left[\beta\,\frac{\tau\,\mu}{\left(x(\lambda)+\mu\right)^2}\,\gamma_L(1+\theta)\right]Z^2$$

$$
\begin{aligned}
&+\Bigg\{ -(1-\beta)(P_B+\delta)\,\frac{\tau\,\mu}{\big(x(\lambda)+\mu\big)^2}\,\gamma_L(1+\theta) \\
&\qquad -\beta\left[(1-\tau)-\big(\tau^{\min}-\tau\,\frac{x(\lambda)}{x(\lambda)+\mu}\big)+\frac{\tau\,\mu}{(x(\lambda)+\mu)}-\frac{\tau\,\mu}{\big(x(\lambda)+\mu\big)^2}\gamma_K\right] \\
&\qquad +\left(\tau^{\min}-\tau\,\frac{x(\lambda)}{x(\lambda)+\mu}\right)\gamma_L\Bigg\}Z \\
&+\ (1-\beta)(P_B+\delta)\left[(1-\tau)-\big(\tau^{\min}-\tau\,\frac{x(\lambda)}{x(\lambda)+\mu}\big)+\frac{\tau\,\mu}{(x(\lambda)+\mu)}-\frac{\tau\,\mu}{\big(x(\lambda)+\mu\big)^2}\gamma_K\right]=0 \qquad (101)
\end{aligned}
$$

For ease of reference, define

$$
a_Z \equiv \beta\,\frac{\tau\,\mu}{\big(x(\lambda)+\mu\big)^2}\,\gamma_L(1+\theta), \qquad (102)
$$

$$
\begin{aligned}
b_Z \equiv &-(1-\beta)(P_B+\delta)\,\frac{\tau\,\mu}{\big(x(\lambda)+\mu\big)^2}\,\gamma_L(1+\theta) \\
&-\beta\left[(1-\tau)-\big(\tau^{\min}-\tau\,\frac{x(\lambda)}{x(\lambda)+\mu}\big)+\frac{\tau\,\mu}{(x(\lambda)+\mu)}-\frac{\tau\,\mu}{\big(x(\lambda)+\mu\big)^2}\gamma_K\right]+\left(\tau^{\min}-\tau\,\frac{x(\lambda)}{x(\lambda)+\mu}\right)\gamma_L,
\end{aligned} \qquad (103)
$$

$$
c_Z \equiv (1-\beta)(P_B+\delta)\left[(1-\tau)-\left(\tau^{\min}-\tau\,\frac{x(\lambda)}{x(\lambda)+\mu}\right)-\frac{\tau\,\mu}{\big(x(\lambda)+\mu\big)^2}\gamma_K\right] \qquad (104)
$$

Then equation 101 is

$$
a_Z Z^2 + b_Z Z + c_Z = 0, \qquad (105)
$$

and the solution for $Z=\omega\lambda$ is

$$
Z = \frac{-\,b_Z \ \pm\ \sqrt{b_Z^2-4\,a_Z\,c_Z}}{2\,a_Z} \qquad (106)
$$

But the terms involving $\dfrac{\tau\,\mu}{x(\lambda)+\mu}$ can safely be ignored, as they represent second-order effects.

Accordingly, the real wage–to–capital ratio, $Z=\omega\lambda$, can be expressed as:

$$
Z = \frac{(1-\beta)(P_B+\delta)}{\beta-\dfrac{(\tau^{\min}-\tau\,\frac{x(\lambda)}{x(\lambda)+\mu})\gamma_L}{1-\tau-\left(\tau^{\min}-\tau\,\frac{x(\lambda)}{x(\lambda)+\mu}\right)}} \qquad (107)
$$

In the case of AETR, we first plug in the relevant P_B in equation 107. Once that is solved, we use $Z=\omega\lambda$ in equation 95 and determine the AETR.

In the case of cost of capital, and hence METR, we solve numerically. Step 1, guess $\tilde{p}_B$. We plug the initial $\tilde{p}_B$ in 107 to determine $Z = \omega\lambda$. We then plug that in equation 93 to check if that cost of capital is consistent with the equation and iterate until we arrive at the right cost of capital result.

1.4 Minimum tax with two periods (with non-qualified refundable tax credit (NQRTC)

Domestic tax uses DG sale-timing (foregone allowances at exit, no immediate tax on sale gain); Pillar Two (GloBE) follows book (nominal) accounting, including the book gain on disposal. A non-qualified refundable tax credit (NQRTC) of size μK_0 affects the GloBE top-up as specified below and also enters the value function as a period-1 inflow.

Definitions

$$X(K_0, L_1) \equiv P_1 F(K_0, L_1) - W_1 L_1 + \big[\theta - (1+\theta)\delta\big] K_0$$

$$D(K_0, L_1) \equiv P_1 F(K_0, L_1) - W_1 L_1 + \big[\theta - (1+\theta)\delta\big] K_0 \tag{108}$$

$$\tau^u_\mu(K_0, L_1) \equiv \tau^{\min} - \tau \frac{X(K_0, L_1)}{D(K_0, L_1)} - \frac{\mu K_0}{D(K_0, L_1)} \tag{109}$$

$$1 + i = (1+r)(1+\theta), \tag{110}$$

$$A = \sum_{t \geq 0} \frac{\phi(1-\phi)^t}{(1+i)^t} = \phi \frac{1+i}{i+\phi}, \tag{111}$$

$$\omega \equiv \frac{W_1}{P_1}, \tag{112}$$

$$\text{CRS:} \quad F(K_0, L_1) = K_0 f(\lambda), \qquad \lambda \equiv \frac{L_1}{K_0}, \tag{113}$$

$$H(\lambda) = F\Big(\frac{K_0}{K_0}, \frac{L_1}{K_0}\Big) - \frac{W_1}{P_1}\frac{L_1}{K_0} = F\Big(1, \frac{L_1}{K_0}\Big) - \frac{W_1}{P_1}\frac{L_1}{K_0} = f(\lambda) - \omega\,\lambda, \tag{114}$$

$$S^{\mathrm{G},\mu}(\lambda) \equiv \frac{\mathcal{B}^{\mathrm{G},\mu}}{K_0} = P_1[H(\lambda) - \gamma_L\,\omega\,\lambda] + \Big[\theta - (1+\theta)\delta - \gamma_K\Big], \tag{115}$$

$$x(\lambda) \equiv P_1\,H(\lambda) + \big[\theta - (1+\theta)\delta\big], \qquad d(\lambda) \equiv x(\lambda), \tag{116}$$

$$\Theta(\lambda) \equiv \tau^{\min} - (\tau\,\frac{x(\lambda)}{d(\lambda)} - \frac{\mu}{d(\lambda)}) = \tau^{\min} - \tau\,\frac{x(\lambda)}{d(\lambda)} + \frac{\mu}{d(\lambda)} \tag{117}$$

Note that μ may vary with the tax rate—as in the case of an ACE—or it may be independent of the tax rate.

Nominal GloBE base and top-up with NQRTC

Nominal GloBE base (levels).

$$\mathcal{B}^{\mathrm{G},\mu}(K_0,L_1)=\big[P_1F(K_0,L_1)-W_1L_1\big]+\Big[\theta-(1+\theta)\delta-\gamma_K\Big]K_0-\gamma_L\,W_1L_1 \tag{118}$$

Per-unit base and top-up rate. Recall $S^{\mathrm{G},\mu}(\lambda)$ from equation 115 and $\Theta(\lambda)$ from 117. The top-up amount (per unit) is

$$\text{Top-up per unit}=\Theta(\lambda)\cdot\max\big\{S^{\mathrm{G},\mu}(\lambda),\,0\big\}. \tag{119}$$

Value function

At $t=0$,

$$V(K_0,L_1)=-K_0+\frac{1}{1+i}\Big\{(1-\tau)\big[P_1F(K_0,L_1)-W_1L_1\big]+(1-\delta)(1+\theta)K_0\Big\}+\tau AK_0-\frac{(1-\delta)(1+\theta)\,\tau A}{1+i}\,K_0$$
$$+\frac{\mu}{1+i}\,K_0-\frac{1}{1+i}\,\Theta(\lambda)\,\max\big\{\mathcal{B}^{\mathrm{G},\mu}(K_0,L_1),\,0\big\} \tag{120}$$

Per unit of K_0, writing $V(K_0,L_1)=K_0\,\mathcal{V}(\lambda)$ and recalling $S^{\mathrm{G},\mu}(\lambda)$,

$$\mathcal{V}(\lambda)=-1+\frac{(1-\tau)\,P_1H(\lambda)+(1-\delta)(1+\theta)}{1+i}+\tau A-\frac{(1-\delta)(1+\theta)\,\tau A}{1+i}+\frac{\mu}{1+i}-\frac{\Theta(\lambda)\,\max\{S^{\mathrm{G},\mu}(\lambda),0\}}{1+i} \tag{121}$$

Derivatives and binding FOC (levels)

For the derivative calculations, we introduce *auxiliary* (working) level objects:

$$X(K_0,L_1)\equiv P_1F(K_0,L_1)-W_1L_1+\big[\theta-(1+\theta)\delta\big]K_0,$$
$$D(K_0,L_1)\equiv X(K_0,L_1)=P_1F(K_0,L_1)-W_1L_1+\big[\theta-(1+\theta)\delta\big]K_0,$$
$$\tau^u_\mu(K_0,L_1)\equiv\tau^{\min}-\tau\,\frac{X(K_0,L_1)}{D(K_0,L_1)}+\frac{\mu}{D(K_0,L_1)}=\tau^{\min}-\tau+\frac{\mu K_0}{D(K_0,L_1)} \tag{122}$$

Recall $\mathcal{B}^{\mathrm{G},\mu}(K_0,L_1)$ from 118. Then

$$\frac{\partial\tau^u_\mu(K_0,L_1)}{\partial L_1}=-\,\tau\,\frac{\mu\,K_0\big(P_1F_L-W_1\big)}{D^2} \tag{123}$$

Binding FOC (levels). When the top-up binds (i.e., $\mathcal{B}^{\mathrm{G},\mu}>0$),

$$0=(1-\tau)\big(P_1F_L-W_1\big)\;-\;\Bigg[\;\underbrace{\frac{\partial\tau^u_\mu}{\partial L_1}}_{-\,\tau\,\frac{\mu\,K_0(P_1F_L-W_1)}{D^2}}\;\mathcal{B}^{\mathrm{G},\mu}\;+\;\tau^u_\mu\;\underbrace{\frac{\partial\mathcal{B}^{\mathrm{G},\mu}}{\partial L_1}}_{P_1F_L-W_1-\gamma_L\,W_1}\;\Bigg] \tag{124}$$

$$\iff (1-\tau)(P_1F_L - W_1) \; + \; \tau \, \frac{\mu \, K_0(P_1F_L - W_1)}{D^2} \, \mathcal{B}^{\mathrm{G},\mu} \; - \; \left(\tau^{\min} - \tau \; + \tfrac{\mu K_0}{D}\right) \left(P_1F_L - W_1 - \gamma_L \, W_1\right) = 0$$

When the top-up does not bind (i.e., $\mathcal{B}^{\mathrm{G},\mu} \leq 0$),

$$0 = (1-\tau)\big(P_1F_L - W_1\big) = 0 \qquad \iff \; F_L = \frac{W_1}{P_1} \tag{125}$$

Optimal labor (per unit)

Non-binding top-up. If $S^{\mathrm{G},\mu}(\lambda^*) \leq 0$, then

$$H'(\lambda^*) = 0 \quad \iff \quad f'(\lambda^*) = \omega \tag{126}$$

Binding top-up. If $S^{\mathrm{G},\mu}(\lambda^*) > 0$, recalling $\Theta(\lambda)$ and $d(\lambda)$ from 117–116, the FOC (per unit) can be written as

$$(1-\tau) \, P_1 H'(\lambda) \; + \; \tau \, \frac{\mu \, P_1 H'(\lambda)}{d(\lambda)^2} \, S^{\mathrm{G},\mu}(\lambda) \; - \; \Theta(\lambda) \, P_1 \big[H'(\lambda) - \gamma_L \, \omega\big] = 0, \tag{127}$$

which implies

$$H'(\lambda^{\mathrm{B}}) = -\frac{\Theta(\lambda^{\mathrm{B}}) \, \gamma_L \, \omega}{(1-\tau) - \Theta(\lambda^{\mathrm{B}}) + \dfrac{\tau \, \mu}{d(\lambda^{\mathrm{B}})^2} \, S^{\mathrm{G},\mu}(\lambda^{\mathrm{B}})}, \tag{128}$$

$$f'(\lambda^{\mathrm{B}}) = \omega \left[1 - \frac{\Theta(\lambda^{\mathrm{B}}) \, \gamma_L}{(1-\tau) - \Theta(\lambda^{\mathrm{B}}) + \dfrac{\tau \, \mu}{d(\lambda^{\mathrm{B}})^2} \, S^{\mathrm{G},\mu}(\lambda^{\mathrm{B}})}\right] \tag{129}$$

Note that, in the absence of a NQRTC, the above will collapse into:

$$f'(\lambda^{\mathrm{B}}) = \omega \left[1 - \frac{(\tau^{min} - \tau)}{(1-\tau) - (\tau^{min} - \tau)} \gamma_L\right] = \omega \left[1 - \frac{\tau^{min} - \tau}{1 - \tau^{min}} \gamma_L\right] \tag{130}$$

Which is the same condition we have established in the section without QRTC and NQRTC.

Cost of capital, at λ^*

Using $(1+i) - (1-\delta)(1+\theta) = (1+\theta)(r+\delta)$ and setting $\mathcal{V}(\lambda^*) = 0$:

Non-binding top-up ($S^{\mathrm{G},\mu}(\lambda^{\mathrm{N}}) \leq 0$)

$$\mathcal{V}(\lambda) = -1 + \frac{(1-\tau)\,(1+\theta)H(\lambda) + (1-\delta)(1+\theta)}{1+i} + \tau A - \frac{(1-\delta)(1+\theta)\,\tau A}{1+i} + \frac{\mu}{1+i} = 0 \quad (131)$$

Simplifying,

$$\mathcal{V}(\lambda) = -1 + \frac{(1-\tau)\,(\tilde{p}_N + \delta)}{1+r} - \frac{(r+\delta)(1-\tau A)}{1+r} + \frac{\mu}{1+i} = 0 \quad (132)$$

$$\tilde{p}^{\mathrm{N}} = \frac{(r+\delta)\,(1-\tau A) \; - \; \dfrac{\mu}{1+\theta}}{1-\tau} - \delta \quad (133)$$

We will show later in the ACE section that under ACE, $\mu = \tau(1+\theta)(r+\delta)(1-A)$

Binding top-up ($S^{\mathrm{G},\mu}(\lambda^{\mathrm{B}}) > 0$)

$$\mathcal{V}(\lambda) = -1 + \frac{(1-\tau)\,P_1 H(\lambda) + (1-\delta)(1+\theta)}{1+i} + \tau A - \frac{(1-\delta)(1+\theta)\,\tau A}{1+i} + \frac{\mu}{1+i} - \frac{\Theta(\lambda)\;\max\{S^{\mathrm{G},\mu}(\lambda), 0\}}{1+i} \quad (134)$$

$$\mathcal{V}(\lambda) = -1 + \frac{(1-\tau)\,(1+\theta)(p_B+\delta) + (1-\delta)(1+\theta)}{1+i} + \tau A - \frac{(1-\delta)(1+\theta)\,\tau A}{1+i} + \frac{\mu}{1+i} - \frac{\Theta(\lambda)\;\max\{S^{\mathrm{G},\mu}(\lambda), 0\}}{1+i} \quad (135)$$

let's denote $\dfrac{\mu}{(1+\theta)(p_B+\delta) + \theta - (1+\theta)\delta} = \xi^{\mu_{nqrtc}}$

Then,

$$\begin{aligned}\mathcal{V}(\lambda) = {} & -1 + \tau A + \frac{(1-\tau)(1+\theta)(p_B+\delta) + (1-\delta)(1+\theta) - (1-\delta)(1+\theta)\tau A + \mu}{1+i} \\ & - \frac{\left(\tau^{\min} - (\tau - \xi^{\mu_{nqrtc}})\right)}{1+i} \\ & \quad \times \max\Big\{0,\, (1+\theta)(p_B+\delta) + \big[\theta - (1+\theta)(r+\delta)A - \gamma_K\big] - \gamma_L\, W_1 \lambda_B\Big\}\end{aligned} \quad (136)$$

$$\begin{aligned}\mathcal{V}(\lambda) = {} & \frac{(1-\tau)\,(p_B+\delta)}{1+r} - \frac{r+\delta}{1+r}(1-\tau A) + \frac{\mu}{1+i} \\ & - \left(\tau^{\min} - (\tau - \xi^{\mu_{nqrtc}})\right) \frac{\max\Big\{0,\, (p_B+\delta) + \big[\frac{\theta}{1+\theta} - \delta - \frac{\gamma_K}{1+\theta}\big] - \gamma_L\, \omega\lambda_B\Big\}}{1+r}\end{aligned}$$

$$\mathcal{V}(\lambda) = \frac{\left[1 - \tau - \left(\tau^{\min} - (\tau - \xi^{\mu_{nqrtc}})\right)\right](p_B + \delta)}{1+r} - \frac{(r+\delta)(1-\tau A)}{1+r} + \frac{\mu}{1+i}$$
$$- \frac{\left(\tau^{\min} - (\tau - \xi^{\mu_{nqrtc}})\right)\left\{\frac{\theta}{1+\theta} - \delta - \frac{\gamma_K}{1+\theta} - \gamma_L\,\omega\,\lambda_B\right\}}{1+r} \tag{137}$$

Further simplifying,

$$\mathcal{V}(\lambda) = \frac{\left[1 - \tau^{\min} - \xi^{\mu_{nqrtc}}\right](p_B + \delta)}{1+r} - \frac{(r+\delta)(1-\tau A)}{1+r} + \frac{\mu}{1+i}$$
$$- \frac{\left(\tau^{\min} - \tau + \xi^{\mu_{nqrtc}}\right)\left\{\frac{\theta}{1+\theta} - \delta - \frac{\gamma_K}{1+\theta} - \gamma_L\,\omega\,\lambda_B\right\}}{1+r} \tag{138}$$

We can use equation 138 to derive the Cost of capital, METR, and AETR as follows:

To find the cost of capital, set the value to zero.

$$\tilde{p}_B = \frac{1}{1 - \tau^{\min} - \xi^{\mu_{nqrtc}}}\Bigg[(r+\delta)(1-\tau A) - \frac{\mu}{1+\theta}$$
$$+ \left(\tau^{\min} - \tau + \xi^{\mu_{nqrtc}}\right)\left(\frac{\theta}{1+\theta} - \delta - \frac{\gamma_K}{1+\theta} - \gamma_L\,\omega\,\lambda_B\right)\Bigg] - \delta \tag{139}$$

Note that since $\xi^{\mu_{nqrtc}}$ is also a function of $\tilde{p}_B$, equation 139 is non-linear and can only be solved numerically.

The AETR:

$$\text{AETR} = \frac{p_B - r - \left(1 - \tau^{\min} - \xi^{\mu_{nqrtc}})\right)(p_B + \delta) + (r+\delta)(1-\tau A) - \frac{\mu}{1+\theta}}{p_B}$$
$$+ \frac{\left(\tau^{\min} - \tau + \xi^{\mu_{nqrtc}}\right)\left\{\frac{\theta}{1+\theta} - \delta - \frac{\gamma_K(1-\phi)}{1+\theta} - \gamma_L\,\omega\,\lambda_B\right\}}{p_B} \tag{140}$$

Further simplifying,

$$\text{AETR} = \frac{1}{p_B}\Bigg\{\left[(\tau^{\min} + \xi^{\mu_{nqrtc}})\right](p_B + \delta) - (r+\delta)\,\tau A - \frac{\mu}{1+\theta} \tag{141}$$

$$+ \left(\tau^{\min} - \tau + \xi^{\mu_{nqrtc}}\right)\left[\frac{\theta}{1+\theta} - \delta - \frac{\gamma_K}{1+\theta} - \gamma_L\,\omega\,\lambda_B\right]\Bigg\} \tag{142}$$

1.4.1 Cobb–Douglas + NQRTC: pinning down $\omega L_1/K_0$

Non-binding top-up (NQRTC present but not binding). With no binding, the FOC is the usual $P_1 F_L = W_1$. Using $F_L = (1-\beta)AK_0^{\beta}L_1^{-\beta}$ and $\pi_1^{d*} = (1+\theta)(p+\delta)K_0$,

$$\boxed{\omega\,\frac{L_1^*}{K_0} = \frac{W_1 L_1^*}{P_1 K_0} = \frac{1-\beta}{\beta}\,(p+\delta)}$$

(Identical to the no-NQRTC case: μ does not affect the non-binding labor FOC.)

Binding top-up with NQRTC. From our NQRTC FOC (per unit),

$$f'(\lambda) = \omega\left[1 - \frac{\Theta(\lambda)\,\gamma_L}{(1-\tau) - \Theta(\lambda) + \dfrac{\tau\,\mu}{d(\lambda)^2}\,S^{\mathrm{G},\mu}(\lambda)}\right] = \omega\left[1 - \frac{\tau^{min} - \tau + \frac{\tau\mu}{d(\lambda)}\,\gamma_L}{(1-\tau) - (\tau^{min} - \tau + \frac{\tau\mu}{d(\lambda)}) + \dfrac{\tau\,\mu}{d(\lambda)^2}\,S^{\mathrm{G},\mu}(\lambda)}\right],$$

Further simplifying,

$$f'(\lambda) = \omega\left[1 - \frac{\left(\tau^{min} - \tau + \frac{\tau\mu}{d(\lambda)}\right)\gamma_L}{(1-\tau^{min} - \frac{\tau\mu}{d(\lambda)}) + \dfrac{\tau\,\mu}{d(\lambda)^2}\,S^{\mathrm{G},\mu}(\lambda)}\right],$$

using the fact that $S^{\mathrm{G},\mu}(\lambda^{\mathrm{B}}) = d(\lambda) - \gamma_k - \gamma_L\omega\lambda(1+\theta)$, we can express marginal product of labor:

$$f'(\lambda) = \omega\left[1 - \frac{\left(\tau^{min} - \tau + \tau\frac{\mu}{d(\lambda^{\mathrm{B}})}\right)\gamma_L}{1 - \tau^{min} - \dfrac{\tau\,\mu}{d(\lambda^{\mathrm{B}})^2}\gamma_k - \dfrac{\tau\,\mu}{d(\lambda^{\mathrm{B}})^2}\gamma_L\omega\lambda(1+\theta)}\right] \tag{143}$$

Since $f = A\lambda^{1-\beta}$, $f'(\lambda) = (1-\beta)A\lambda^{-\beta}$

Then, multiplying equation 143 by λ and denoting $\omega\lambda$ by Z, we get:

$$(1-\beta)A\lambda^{1-\beta} = Z\left[1 - \frac{\left(\tau^{min} - \tau + \tau\frac{\mu}{d(\lambda^{\mathrm{B}})}\right)\gamma_L}{1 - \tau^{min} - \dfrac{\tau\,\mu}{d(\lambda^{\mathrm{B}})^2}\gamma_k - \dfrac{\tau\,\mu}{d(\lambda^{\mathrm{B}})^2}\gamma_L Z(1+\theta)}\right] \tag{144}$$

Also note that in equibirum, $f(\lambda) - \omega\lambda = P_B + \delta$. Therefore, $A\lambda^{1-\beta} - Z = P_B + \delta$ or $A\lambda^{1-\beta} = Z + P_B + \delta$

We can use these notations and equation 144 to express the equilibrium condition as a function of Z.

$$(1-\beta)(Z+P_B+\delta) = Z\left[1-\frac{\left(\tau^{min}-\tau+\tau\frac{\mu}{d(\lambda^{\mathrm{B}})}\right)\gamma_L}{1-\tau^{min}-\frac{\tau\,\mu}{d(\lambda^{\mathrm{B}})^2}\gamma_k-\frac{\tau\,\mu}{d(\lambda^{\mathrm{B}})^2}\gamma_L Z(1+\theta)}\right] \tag{145}$$

Which can be simplified to:

$$(1-\beta)(P_B+\delta) = Z\left[\beta-\frac{\left(\tau^{min}-\tau+\tau\frac{\mu}{d(\lambda^{\mathrm{B}})}\right)\gamma_L}{1-\tau^{min}-\frac{\tau\,\mu}{d(\lambda^{\mathrm{B}})^2}\gamma_k-\frac{\tau\,\mu}{d(\lambda^{\mathrm{B}})^2}\gamma_L Z(1+\theta)}\right] \tag{146}$$

Collecting similar terms:

$$\begin{aligned}(1-\beta)(P_B+\delta)&\left[1-\tau^{\mathrm{min}}-\frac{\tau\,\mu}{d(\lambda^{\mathrm{B}})^2}\,\gamma_K\right]-(1-\beta)(P_B+\delta)\,\frac{\tau\,\mu}{d(\lambda^{\mathrm{B}})^2}\,\gamma_L\,Z(1+\theta)\\ &=Z\left[\beta\left(1-\tau^{\mathrm{min}}-\frac{\tau\,\mu}{d(\lambda^{\mathrm{B}})^2}\,\gamma_K-\frac{\tau\,\mu}{d(\lambda^{\mathrm{B}})^2}\,\gamma_L\,Z(1+\theta)\right)-\left(\tau^{\mathrm{min}}-\tau+\tau\,\frac{\mu}{d(\lambda^{\mathrm{B}})}\right)\gamma_L\right]\end{aligned} \tag{147}$$

Expanding the right hand side:

$$\mathrm{RHS} = Z\beta\left(1-\tau^{\mathrm{min}}-\frac{\tau\,\mu}{d_B^2}\,\gamma_K\right)-Z\beta\,\frac{\tau\,\mu}{d_B^2}\,\gamma_L\,Z(1+\theta)-Z\left(\tau^{\mathrm{min}}-\tau+\tau\,\frac{\mu}{d_B}\right)\gamma_L \tag{148}$$

$$=\beta Z\left(1-\tau^{\mathrm{min}}-\frac{\tau\,\mu}{d_B^2}\,\gamma_K\right)-\beta\,\frac{\tau\,\mu}{d_B^2}\,\gamma_L(1+\theta)\,Z^2-\left(\tau^{\mathrm{min}}-\tau+\tau\,\frac{\mu}{d_B}\right)\gamma_L Z \tag{149}$$

And the left hand side is:

$$\mathrm{LHS} = (1-\beta)(P_B+\delta)\left[1-\tau^{\mathrm{min}}-\frac{\tau\,\mu}{d_B^2}\,\gamma_K\right]-(1-\beta)(P_B+\delta)\,\frac{\tau\,\mu}{d_B^2}\,\gamma_L(1+\theta)\,Z \tag{150}$$

Setting $LHS = RHS$ and bringing everything to one side:

$$0 = \mathrm{LHS}-\mathrm{RHS} \tag{151}$$

$$=(1-\beta)(P_B+\delta)\left[1-\tau^{\mathrm{min}}-\frac{\tau\,\mu}{d_B^2}\,\gamma_K\right]-(1-\beta)(P_B+\delta)\,\frac{\tau\,\mu}{d_B^2}\,\gamma_L(1+\theta)\,Z \tag{152}$$

$$-\beta Z\left(1-\tau^{\mathrm{min}}-\frac{\tau\,\mu}{d_B^2}\,\gamma_K\right)+\beta\,\frac{\tau\,\mu}{d_B^2}\,\gamma_L(1+\theta)\,Z^2+\left(\tau^{\mathrm{min}}-\tau+\tau\,\frac{\mu}{d_B}\right)\gamma_L Z \tag{153}$$

$$\beta \frac{\tau\,\mu}{d_B^2}\,\gamma_L(1+\theta)\,Z^2 + \Bigg\{ -(1-\beta)(P_B+\delta)\,\frac{\tau\,\mu}{d_B^2}\,\gamma_L(1+\theta) \tag{154}$$

$$-\beta\left(1-\tau^{\min}-\frac{\tau\,\mu}{d_B^2}\,\gamma_K\right)+\left(\tau^{\min}-\tau+\tau\,\frac{\mu}{d_B}\right)\gamma_L\Bigg\}Z \tag{155}$$

$$+(1-\beta)(P_B+\delta)\left[1-\tau^{\min}-\frac{\tau\,\mu}{d_B^2}\,\gamma_K\right]=0, \tag{156}$$

$$d_B \equiv d(\lambda^{\mathrm{B}}) = (1+\theta)(P_B+\delta)+\theta-(1+\theta)\delta, \tag{157}$$

$$a_Z = \beta\,\frac{\tau\,\mu}{d_B^2}\,\gamma_L(1+\theta), \tag{158}$$

$$b_Z = -(1-\beta)(P_B+\delta)\,\frac{\tau\,\mu}{d_B^2}\,\gamma_L(1+\theta)-\beta\left(1-\tau^{\min}-\frac{\tau\,\mu}{d_B^2}\,\gamma_K\right)+\left(\tau^{\min}-\tau+\tau\,\frac{\mu}{d_B}\right)\gamma_L, \tag{159}$$

$$c_Z = (1-\beta)(P_B+\delta)\left[1-\tau^{\min}-\frac{\tau\,\mu}{d_B^2}\,\gamma_K\right], \tag{160}$$

$$Z = \omega\,\lambda^{\mathrm{B}} \tag{161}$$

$$= \frac{-\,b_Z \pm \sqrt{b_Z^2-4a_Zc_Z}}{2a_Z} \tag{162}$$

$$Z = \frac{(1-\beta)(P_B+\delta)\tau\mu\gamma_L(1+\theta)+\beta\big[(1-\tau^{\min})d_B^2-\tau\mu\gamma_K\big]-\big[(\tau^{\min}-\tau)d_B^2+\tau\mu d_B\big]\gamma_L}{2\beta\tau\mu\gamma_L(1+\theta)}$$

$$\pm\ \frac{1}{2\beta\tau\mu\gamma_L(1+\theta)}\sqrt{\begin{aligned}&\Big[(1-\beta)(P_B+\delta)\tau\mu\gamma_L(1+\theta)+\beta\big[(1-\tau^{\min})d_B^2-\tau\mu\gamma_K\big]\\&\qquad-\big[(\tau^{\min}-\tau)d_B^2+\tau\mu d_B\big]\gamma_L\Big]^2\\&-4\beta\tau\mu\gamma_L(1+\theta)(1-\beta)(P_B+\delta)\big[(1-\tau^{\min})d_B^2-\tau\mu\gamma_K\big]\end{aligned}} \tag{163}$$

But the terms involving $\dfrac{\tau\,\mu}{x(\lambda)+\mu}$ can safely be ignored, as they represent second-order effects.

Accordingly, the real wage–to–capital ratio, $Z = \omega\lambda$, can be expressed as:

$$Z = \frac{(1-\beta)(P_B+\delta)}{\beta-\dfrac{(\tau^{\min}-\tau)\,\gamma_L}{1-\tau^{\min}}} \tag{164}$$

The way to solve the equations in the case of NQRTC: For AETR, plug in the profitability in the equation A.3.1, find the value of Z. Then, plug that in the AETR equation derived (equation 141).

For cost of capital, plug the initial guess of $\tilde{p}_B$ in the A.3.1, compute Z, then check the consistency with the cost of capital equation 139.

1.5 Minimum tax with two periods (with Qualified Tax Incentives (QTIs))

The rule agreed on January 6, 2026 provides that refundable tax credits—whether designated as QRTCs or NQRTCs—may be recharacterized as increases in covered taxes paid for GloBE purposes, subject to a quantitative cap. The cap is defined as the maximum of (i) 5.5 percent of payroll, (ii) 5.5 percent of depreciation, or (iii) 1 percent of qualifying expenditure (capital), if the taxpayer so elects.

Let

$$\overline{C} \equiv \max\{0.055 \cdot \text{payroll},\ 0.055 \cdot \text{depreciation},\ 0.01K_0\}, \qquad C \equiv \min\{\text{Incentive}, \overline{C}\}.$$

Thus, only the portion C of the incentive can be treated as an increase in covered taxes for GloBE purposes.

Period-by-period implication. In each period, total tax liability is the sum of domestic tax and the GloBE top-up tax:

$$\text{Total tax} = \text{Domestic tax} + \text{GloBE tax}. \tag{165}$$

(A) QRTC treated as covered taxes up to the cap

Under a QRTC, covered income is increased by the credit, but the amount treated as covered taxes is capped at $C = \min\{QRTC, \overline{C}\}$. The resulting total tax can be written as

$$\text{Total tax} = \tau\pi - QRTC + \left[\tau^{\min} - \frac{\tau\pi}{\pi + QRTC - C}\right]\Big(\pi + QRTC - C - SBIE\Big). \tag{166}$$

(B) NQRTC (treated as a reduction in taxes paid)

For comparison, let $NQRTC$ denote a non-qualified refundable credit (or a credit that is not treated as an increase in covered taxes). Under the same cap concept (i.e., only the portion $C = \min\{NQRTC, \overline{C}\}$ is treated as "qualified" for purposes of the adjustment), total tax can be expressed as

$$\text{Total tax} = \tau\pi - NQRTC + \left[\tau^{\min} - \frac{\tau\pi - NQRTC + C}{\pi}\right]\Big(\pi - SBIE\Big), \tag{167}$$

where $C = \min\{NQRTC, \overline{C}\}$ and $\overline{C} = \max\{0.055 \cdot \text{payroll},\ 0.055 \cdot \text{depreciation},\ 0.01K_0\}$.

Interpretation. If the incentive is *fully within the cap*—that is, Incentive $\leq \overline{C}$, so that $C =$ Incentive—the QTI treatment eliminates any distinction between QRTCs and NQRTCs for GloBE purposes: irrespective of their legal classification, both affect the minimum-tax computation only through the same capped adjustment C. When Incentive $> \overline{C}$, the portion of the incentive above the cap does not receive QTI treatment and therefore reintroduces a wedge between QRTCs and NQRTCs under the minimum tax.

Importantly, this does *not* imply that incentives above the cap are neutral for investment. Additional incentives beyond the cap may trigger a GloBE top-up, but because they further reduce domestic tax liabilities, they can still lower both the marginal and average effective tax rates. As a result, incentives that exceed the cap may lead to even lower METRs and AETRs than incentives set exactly at the cap, despite increasing the GloBE top-up.

In the following, we highight the METR and AETR for incentives under the cap. Let a fraction $\alpha \in [0,1]$ of the investment be financed by debt. The nominal interest rate is i and the real required return is r, with $1+i=(1+r)(1+\theta)$. Interest is deductible against domestic taxable income. Define the real (per-unit-of-capital) value of the domestic interest deduction as

$$\Psi \equiv \alpha \, \frac{i(1-\tau\phi)}{1+\theta}. \tag{168}$$

Environment and notation

$$1+i = (1+r)(1+\theta), \tag{169}$$

$$A = \sum_{t\geq 0} \frac{\phi(1-\phi)^t}{(1+i)^t} = \phi\frac{1+i}{i+\phi}, \tag{170}$$

$$\omega \equiv \frac{W_1}{P_1}, \tag{171}$$

$$\rho \equiv \frac{\tau^{\min} - \tau}{1-\tau^{\min}}. \tag{172}$$

Qualified tax incentives (within the cap). We consider two incentive instruments, each assumed to be fully within the QTI cap and therefore excluded from covered income and covered taxes under Pillar Two. Let $qti^L \in [0,1]$ and $qti^K \in [0,1]$ denote utilization (or scaling) factors within the cap. The statutory cap parameter is common across instruments and fixed at $s_L = s_K \equiv 0.055$.

$$\mathcal{I}_1^L \equiv s_L \, qti^L \, W_1 L_1, \qquad qti^L \in [0,1], \qquad s_L \equiv 0.055, \tag{173}$$

$$\mathcal{I}_1^K \equiv s_K \, qti^K \, \delta K_0, \qquad qti^K \in [0,1], \qquad s_K \equiv 0.055. \tag{174}$$

The payroll-based incentive (Type L) distorts labor demand (through the labor FOC). The capital-based incentive (Type K) does not distort labor demand.

With CRS,

$$F(K_0, L_1) = K_0 f(\lambda), \qquad \lambda \equiv \frac{L_1}{K_0}.$$

Define

$$H(\lambda) = f(\lambda) - \omega\lambda, \tag{175}$$

and the real operating return net of economic depreciation,

$$p(\lambda) = H(\lambda) - \delta. \tag{176}$$

GloBE excess profit

$$\begin{aligned} \mathcal{B}^{\mathrm{G}}(K_0, L_1) = {} & [P_1 F(K_0, L_1) - W_1 L_1] + [(1+\theta)(1-\delta) - (1-\phi)]K_0 \\ & - (\phi + \gamma_K)K_0 - \alpha\, i(1-\tau\phi) - \gamma_L W_1 L_1. \end{aligned} \tag{177}$$

$$S^{\mathrm{G}}(\lambda) = P_1[H(\lambda) - \gamma_L \omega\lambda] + \big[\theta - (1+\theta)\delta - \alpha\, i(1-\tau\phi) - \gamma_K\big]. \tag{178}$$

Value function

$$\begin{aligned} V(K_0, L_1) = {} & -K_0 + \frac{1}{1+i}\Big\{(1-\tau)[P_1 F(K_0, L_1) - W_1 L_1] + (1-\delta)(1+\theta)K_0\Big\} + \tau A K_0 \\ & - \frac{(1-\delta)(1+\theta)\tau A}{1+i} K_0 + \tau\alpha\, \frac{i(1-\tau\phi)}{1+i} + \frac{s_L q t i^L\, W_1 L_1}{1+i} + \frac{s_K q t i^K\, \delta K_0}{1+i} - \frac{\tau^u}{1+i} \max\{\mathcal{B}^{\mathrm{G}}(K_0, L_1), 0\} \\ = {} & K_0\, \mathcal{V}(\lambda). \end{aligned} \tag{179}$$

$$\begin{aligned} \mathcal{V}(\lambda) = {} & \frac{(1-\tau)H(\lambda)}{1+r} - (1-\tau A)\frac{r+\delta}{1+r} + \tau\alpha\, \frac{i(1-\tau\phi)}{1+i} \\ & + \frac{s_L q t i^L\, \omega\lambda}{1+r} + \frac{s_K q t i^K\, \delta}{1+i} - \frac{\tau^u}{1+i} \max\{S^{\mathrm{G}}(\lambda), 0\}. \end{aligned} \tag{180}$$

Labor choice

Type L (payroll-based).

$$\begin{aligned} f'(\lambda^L_{\mathrm{NB}}) &= \left(1 - \frac{s_L q t i^L}{1-\tau}\right)\omega, \\ f'(\lambda^L_{\mathrm{B}}) &= \left(1 - \rho\gamma_L - \frac{s_L q t i^L}{1-\tau^{\min}}\right)\omega \end{aligned} \tag{181}$$

Type K (capital-based).

$$f'(\lambda_{\mathrm{NB}}^{K}) = \omega$$
$$f'(\lambda_{\mathrm{B}}^{K}) = (1-\rho\gamma_L)\omega \tag{182}$$

Validity:

$$S^{\mathrm{G}}(\lambda_{\mathrm{NB}}) \le 0, \qquad S^{\mathrm{G}}(\lambda_{\mathrm{B}}) > 0.$$

Non-binding regime ($\tau^u \le 0$) or excess profit is non-positive

Cost of capital.

$$\tilde{p}_{\mathrm{NB}}^{L} = \frac{(r+\delta)(1-\tau A) - s_L q t i^L (\omega\lambda)_{\mathrm{NB}}^{L} - \tau\alpha\,\frac{i(1-\tau\phi)}{1+\theta}}{1-\tau} - \delta$$
$$\tilde{p}_{\mathrm{NB}}^{K} = \frac{(r+\delta)(1-\tau A) - \frac{s_K q t i^K \delta}{1+\theta} - \tau\alpha\,\frac{i(1-\tau\phi)}{1+\theta}}{1-\tau} - \delta \tag{183}$$

AETR.

$$AETR_{\mathrm{NB}}^{L}(p) = \frac{\tau(p+\delta) - (r+\delta)\tau A - s_L q t i^L (\omega\lambda)_{\mathrm{NB}}^{L} - \tau\alpha\,\frac{i(1-\tau\phi)}{1+\theta}}{p}$$
$$AETR_{\mathrm{NB}}^{K}(p) = \frac{\tau(p+\delta) - (r+\delta)\tau A - \frac{s_K q t i^K \delta}{1+\theta} - \tau\alpha\,\frac{i(1-\tau\phi)}{1+\theta}}{p} \tag{184}$$

Binding regime ($\tau^u > 0$) or Excess Profit is Positive

Define

$$a \equiv \frac{\theta}{1+\theta} - \delta - \frac{\gamma_K}{1+\theta} - \alpha\,\frac{i(1-\tau\phi)}{1+\theta}$$

Cost of capital.

$$\tilde{p}_{\mathrm{B}}^{L} = \frac{(r+\delta)(1-\tau A) + (\tau^{\min}-\tau)\big[a - \gamma_L(\omega\lambda)_{\mathrm{B}}^{L}\big] - s_L q t i^L (\omega\lambda)_{\mathrm{B}}^{L} - \tau\alpha\,\frac{i(1-\tau\phi)}{1+\theta}}{1-\tau^{\min}} - \delta \tag{185}$$
$$\tilde{p}_{\mathrm{B}}^{K} = \frac{(r+\delta)(1-\tau A) + (\tau^{\min}-\tau)\big[a - \gamma_L(\omega\lambda)_{\mathrm{B}}^{K}\big] - \frac{s_K q t i^K \delta}{1+\theta} - \tau\alpha\,\frac{i(1-\tau\phi)}{1+\theta}}{1-\tau^{\min}} - \delta \tag{186}$$

AETR.

$$AETR_{\mathrm{B}}^{L}(p) = \frac{\tau^{\min}(p+\delta) - (r+\delta)\tau A + (\tau^{\min}-\tau)\big[a - \gamma_L(\omega\lambda)_{\mathrm{B}}^{L}\big] - s_L q t i^L (\omega\lambda)_{\mathrm{B}}^{L} - \tau\alpha\,\frac{i(1-\tau\phi)}{1+\theta}}{p} \tag{187}$$
$$AETR_{\mathrm{B}}^{K}(p) = \frac{\tau^{\min}(p+\delta) - (r+\delta)\tau A + (\tau^{\min}-\tau)\big[a - \gamma_L(\omega\lambda)_{\mathrm{B}}^{K}\big] - \frac{s_K q t i^K \delta}{1+\theta} - \tau\alpha\,\frac{i(1-\tau\phi)}{1+\theta}}{p} \tag{188}$$

Cobb–Douglas specialization

Let

$$F(K,L) = \mathcal{A}K^{\beta}L^{1-\beta}, \qquad 0<\beta<1.$$

Define wedges

$$\kappa_{\mathrm{NB}}^{L} = 1 - \frac{s_L qti^L}{1-\tau}, \qquad \kappa_{\mathrm{B}}^{L} = 1 - \rho\gamma_L - \frac{s_L qti^L}{1-\tau^{\min}}, \tag{189}$$

$$\kappa_{\mathrm{NB}}^{K} = 1, \qquad \kappa_{\mathrm{B}}^{K} = 1 - \rho\gamma_L \tag{190}$$

Then

$$(\omega\lambda)_j^x = m_j^x(p_j^x + \delta), \qquad m_j^x \equiv \frac{1-\beta}{\kappa_j^x - (1-\beta)}, \tag{191}$$

for regime $j \in \{\mathrm{NB}, \mathrm{B}\}$ and type $x \in \{L, K\}$.

Closed-form results under Cobb–Douglas

Cost of Capital

Non-binding.

$$\tilde{p}_{\mathrm{NB}}^{L} = \frac{(r+\delta)(1-\tau A) - \tau\alpha\,\frac{i(1-\tau\phi)}{1+\theta}}{(1-\tau) + s_L qti^L\, m_{\mathrm{NB}}^{L}} - \delta, \tag{192}$$

$$\tilde{p}_{\mathrm{NB}}^{K} = \frac{(r+\delta)(1-\tau A) - \frac{s_K qti^K\,\delta}{1+\theta} - \tau\alpha\,\frac{i(1-\tau\phi)}{1+\theta}}{1-\tau} - \delta$$

Binding.

$$\tilde{p}_{\mathrm{B}}^{L} = \frac{(r+\delta)(1-\tau A) + (\tau^{\min}-\tau)a - \tau\alpha\,\frac{i(1-\tau\phi)}{1+\theta}}{(1-\tau^{\min}) + m_{\mathrm{B}}^{L}\big[(\tau^{\min}-\tau)\gamma_L + s_L qti^L\big]} - \delta, \tag{193}$$

$$\tilde{p}_{\mathrm{B}}^{K} = \frac{(r+\delta)(1-\tau A) + (\tau^{\min}-\tau)a - \frac{s_K qti^K\,\delta}{1+\theta} - \tau\alpha\,\frac{i(1-\tau\phi)}{1+\theta}}{(1-\tau^{\min}) + m_{\mathrm{B}}^{K}(\tau^{\min}-\tau)\gamma_L} - \delta$$

AETR

Non-binding (NB).

Type L (payroll-based).

$$\boxed{AETR_{\mathrm{NB}}^{L}(p) = \frac{\Big(\tau - s_L qti^L\, m_{\mathrm{NB}}^{L}\Big)(p+\delta) - (r+\delta)\tau A - \tau\alpha\,\frac{i(1-\tau\phi)}{1+\theta}}{p}} \tag{194}$$

Type K (capital-based).

$$\boxed{AETR^K_{\text{NB}}(p) = \frac{\tau(p+\delta) - (r+\delta)\tau A - \frac{s_K qti^K \delta}{1+\theta} - \tau\alpha\,\frac{i(1-\tau\phi)}{1+\theta}}{p}} \tag{195}$$

Binding (B).

Type L (payroll-based).

$$\boxed{AETR^L_{\text{B}}(p) = \frac{\Big(\tau^{\min} - m^L_{\text{B}}\big[(\tau^{\min}-\tau)\gamma_L + s_L qti^L\big]\Big)(p+\delta) - (r+\delta)\tau A + (\tau^{\min}-\tau)a - \tau\alpha\,\frac{i(1-\tau\phi)}{1+\theta}}{p}} \tag{196}$$

Type K (capital-based).

$$\boxed{AETR^K_{\text{B}}(p) = \frac{\Big(\tau^{\min} - (\tau^{\min}-\tau)\gamma_L\, m^K_{\text{B}}\Big)(p+\delta) - (r+\delta)\tau A + (\tau^{\min}-\tau)a - \frac{s_K qti^K \delta}{1+\theta} - \tau\alpha\,\frac{i(1-\tau\phi)}{1+\theta}}{p}} \tag{197}$$

2 Cash–Flow Tax

2.1 Without Pillar Two

The key difference between the standard CIT and the CFT, in the absence of Pillar Two, is that under a CFT the firm receives an immediate deduction equal to the full cost of investment in the initial period; hence, $A = 1$. In addition, interest deductions are not permitted.

Accordingly, the AETR and the cost of capital under a CFT can be obtained by setting $A = 1$ in equations 5 and 8. Note that, without Pillar Two, the cost of capital and the AETR are identical for equity-financed and debt-financed projects; that is, there is no debt bias.

$$\tilde{p} = \frac{(r+\delta)(1-\tau)}{1-\tau} - \delta \Rightarrow \tilde{p} = r \tag{198}$$

$$AETR = \tau\frac{(p+\delta) - (r+\delta)\tau}{p} = \tau\frac{p-r}{p} \tag{199}$$

2.2 With top up

2.2.1 Equity Financing

If the project is equity-financed, immediate expensing is purely a timing issue. Under a cash-flow tax, the initial depreciation allowance does not affect the top-up tax rate. Accordingly, both the cost of capital and the AETR are obtained by setting $A = 1$ in the relevant equations 36 and 37

$$\tilde{p}_B = \frac{1}{1-\tau^{\min}}\Big[(r+\delta)(1-\tau) + (\tau^{\min}-\tau)\Big\{\frac{\theta}{1+\theta} - \delta - \frac{\gamma_K}{1+\theta} - \gamma_L\,\omega\,\lambda\Big\}\Big] - \delta \tag{200}$$

$$AETR = \frac{\tau^{min}(p_B+\delta) - (r+\delta)\tau + (\tau^{\min}-\tau)\left[\frac{\theta}{1+\theta} - \delta - \frac{\gamma_K}{1+\theta} - \gamma_L\,\omega\,\lambda\right]}{p_B} \tag{201}$$

With Cobb–Douglas production. We can use equations 59 and 60, and set $A = 1$.

$$\tilde{p}_B = \frac{\left[(r+\delta)(1-\tau) + (\tau^{\min}-\tau)\left[\frac{\theta}{1+\theta} - \delta - \frac{\gamma_K}{1+\theta}\right]\right]}{(1-\tau^{\min}) + (\tau^{\min}-\tau)\left(\gamma_L\,\frac{1-\beta}{\beta-\rho\gamma_L}\right)} - \delta \tag{202}$$

$$\begin{aligned} AETR = \frac{1}{p_B}\Bigg(&(p_B+\delta)\left[\tau^{min} - (\tau^{\min}-\tau)\,\frac{\gamma_L(1-\beta)}{\beta-\rho\gamma_L}\right] - (r+\delta)\tau \\ &+ (\tau^{\min}-\tau)\left[\frac{\theta}{1+\theta} - \delta - \frac{\gamma_K}{1+\theta}\right]\Bigg) \end{aligned} \tag{203}$$

2.2.2 Debt Financing

Domestic tax uses DG sale-timing (no immediate tax on sale gain); Pillar Two (GloBE) follows book (nominal) accounting, including the book gain on disposal. The domestic tax does not account for interest on debt whereas the GLoBE income includes deduction for interest on debt.

Definitions

$$X(K_0,L_1) \equiv P_1F(K_0,L_1) - W_1L_1 + \big[\theta - (1+\theta)\delta\big]K_0, \qquad D(K_0,L_1) \equiv X(K_0,L_1) - i(1-\tau)K_0, \tag{204}$$

$$\tau_\mu^u(K_0, L_1) \equiv \tau^{\min} - \tau \, \frac{X(K_0, L_1)}{D(K_0, L_1)}, \tag{205}$$

$$1 + i = (1 + r)(1 + \theta), \tag{206}$$

$$A = \sum_{t \geq 0} \frac{\phi(1-\phi)^t}{(1+i)^t} = \phi \, \frac{1+i}{i+\phi}, \tag{207}$$

$$\omega \equiv \frac{W_1}{P_1}, \tag{208}$$

$$\text{CRS:} \quad F(K_0, L_1) = K_0 \, f(\lambda), \qquad \lambda \equiv \frac{L_1}{K_0}, \tag{209}$$

$$H(\lambda) = F\Big(1, \frac{L_1}{K_0}\Big) - \frac{W_1}{P_1} \frac{L_1}{K_0} = f(\lambda) - \omega \, \lambda, \tag{210}$$

$$S^{\mathrm{G},\mu}(\lambda) \equiv \frac{\mathcal{B}^{\mathrm{G},\mu}}{K_0} = P_1\big[H(\lambda) - \gamma_L \, \omega \, \lambda\big] + \big[\theta - (1+\theta)\delta - \gamma_K - i(1-\tau)\big], \tag{211}$$

$$x(\lambda) \equiv P_1 \, H(\lambda) + \theta - (1+\theta)\delta, \qquad d(\lambda) \equiv x(\lambda) - i(1-\tau), \tag{212}$$

$$\Theta(\lambda) \equiv \tau^{\min} - \tau \, \frac{x(\lambda)}{d(\lambda)} \tag{213}$$

The FOC with respect to labor is

$$f'(\lambda) = \omega \left[1 - \frac{\left(\tau^{min} - \tau \frac{x(\lambda)}{D(\lambda)}\right)\gamma_L}{(1-\tau) - \left(\tau^{min} - \tau \frac{x(\lambda)}{D(\lambda))}\right) - \frac{\tau \, i(1-\tau)}{D(\lambda)} + \frac{\tau \, i(1-\tau)}{D(\lambda))^2} \Big[\gamma_K + \gamma_L \omega \lambda (1+\theta)\Big]} \right] \tag{214}$$

Binding top-up ($S^{\mathrm{G},\mu}(\lambda^{\mathrm{B}}) > 0$).

$$\mathcal{V}(\lambda) = -1 + \frac{(1-\tau) \, P_1 H(\lambda) + (1-\delta)(1+\theta)}{1+i} + \tau - \frac{(1-\delta)(1+\theta) \, \tau}{1+i} - \frac{\Theta(\lambda) \, \max\{S^{\mathrm{G},\mu}(\lambda), 0\}}{1+i} \tag{215}$$

let's denote $\dfrac{(1+\theta)(p_B+\delta) + \theta - (1+\theta)(r+\delta)}{(1+\theta)(p_B+\delta) + \theta - (1+\theta)(r+\delta) - i(1-\tau)} = \xi^{\mu_{cft}}$

Then,

$$\begin{aligned} \mathcal{V}(\lambda) = -1 + \tau + \frac{(1-\tau)(1+\theta)(p_B+\delta) + (1-\delta)(1+\theta) - (1-\delta)(1+\theta)\tau}{1+i} \\ - \frac{\left(\tau^{\min} - \tau \, \xi^{\mu_{cft}}\right)}{1+i} \\ \times \max\Big\{0, \, (1+\theta)(p_B+\delta) + \big[\theta - (1+\theta)\delta - i(1-\tau) - \gamma_K\big] - \gamma_L \, W_1 \lambda_B\Big\} \end{aligned} \tag{216}$$

$$\mathcal{V}(\lambda) = \frac{(1-\tau)\,(p_B+\delta)}{1+r} - \frac{r+\delta}{1+r}(1-\tau)$$
$$- \left(\tau^{\min} - \tau\,\xi^{\mu_{cft}}\right)\frac{\max\left\{0,\ (p_B+\delta) + \left[\frac{\theta}{1+\theta} - \delta - \frac{i(1-\tau)}{1+\theta} - \frac{\gamma_K}{1+\theta}\right] - \gamma_L\,\omega\lambda_B\right\}}{1+r}$$

$$\mathcal{V}(\lambda) = \frac{[1-\tau-(\tau^{\min}-\tau\,\xi^{\mu})](p_B+\delta)}{1+r} - \frac{(r+\delta)(1-\tau)}{1+r}$$
$$- \frac{\left(\tau^{\min} - \tau\,\xi^{\mu_{\text{cft}}}\right)\left[\frac{\theta}{1+\theta} - \delta - \frac{i(1-\tau)}{1+\theta} - \frac{\gamma_K}{1+\theta} - \gamma_L\,\omega\,\lambda_B\right]}{1+r} \tag{217}$$

We can use equation 217 to derive the Cost of capital, METR, and AETR as follows:

To find the cost of capital, set the value to zero.

$$\tilde{p}_B = \frac{1}{1-\tau-\left(\tau^{\min}-\tau\,\xi^{\mu_{cft}}\right)}\Bigg[(r+\delta)(1-\tau)$$
$$+\left(\tau^{\min}-\tau\,\xi^{\mu_{cft}}\right)\left(\frac{\theta}{1+\theta} - \delta - \frac{i(1-\tau)}{1+\theta} - \frac{\gamma_K}{1+\theta} - \gamma_L\,\omega\,\lambda_B\right)\Bigg] - \delta \tag{218}$$

Note that since $\xi^{\mu_{cft}}$ is also a function of $\tilde{p}_B$, equation 218 is non-linear and can only be solved numerically.

The AETR:

$$\text{AETR} = \frac{p_B - r - \left(1-\tau-(\tau^{\min}-\tau\xi^{\mu})\right)(p_B+\delta) + (r+\delta)(1-\tau)}{p_B}$$
$$+ \frac{\left(\tau^{\min}-\tau\xi^{\mu_{cft}}\right)\left\{\frac{\theta}{1+\theta} - \delta - \frac{i(1-\tau)}{1+\theta} - \frac{\gamma_K}{1+\theta} - \gamma_L\,\omega\,\lambda_B\right\}}{p_B} \tag{219}$$

Further simplifying,

$$\text{AETR} = \frac{\left[\tau + (\tau^{\min}-\tau\xi^{\mu_{cft}})\right](p_B+\delta) - (r+\delta)\tau}{p_B}$$
$$+ \frac{\left(\tau^{\min}-\tau\xi^{\mu_{cft}}\right)\left\{\frac{\theta}{1+\theta} - \delta - \frac{i(1-\tau)}{1+\theta} - \frac{\gamma_K}{1+\theta} - \gamma_L\,\omega\,\lambda_B\right\}}{p_B} \tag{220}$$

We assume quadratic production function to parameterize payroll to capital ratio.

Using equation 214 and $Z = \omega\lambda$

$$(1-\beta)(p_B+\delta) = Z\left[\beta - \frac{\left(\tau^{min} - \tau\frac{x(\lambda)}{D(\lambda)}\right)\gamma_L}{(1-\tau) - \left(\tau^{min} - \tau\frac{x(\lambda)}{D(\lambda))}\right) - \dfrac{\tau\, i(1-\tau)}{D(\lambda)} + \dfrac{\tau\, i(1-\tau)}{(D(\lambda))^2}\Big[\gamma_K + \gamma_L Z(1+\theta)\Big]}\right] \tag{221}$$

Would simplify to the following quadratic equation:

$$\begin{aligned}
0 = {} & \beta\,\frac{\tau\, i(1-\tau)}{D(\lambda)^2}\,\gamma_L(1+\theta)\, Z^2 \\
& + \Bigg\{\beta\Big[(1-\tau) - \left(\tau^{\min} - \tau\,\tfrac{x(\lambda)}{D(\lambda)}\right) - \tfrac{\tau\, i(1-\tau)}{D(\lambda)} + \tfrac{\tau\, i(1-\tau)}{D(\lambda)^2}\,\gamma_K\Big] \\
& \qquad - \left(\tau^{\min} - \tau\,\tfrac{x(\lambda)}{D(\lambda)}\right)\gamma_L - (1-\beta)(p_B+\delta)\,\tfrac{\tau\, i(1-\tau)}{D(\lambda)^2}\,\gamma_L(1+\theta)\Bigg\} Z \\
& - (1-\beta)(p_B+\delta)\left[(1-\tau) - \left(\tau^{\min} - \tau\,\tfrac{x(\lambda)}{D(\lambda)}\right) - \tfrac{\tau\, i(1-\tau)}{D(\lambda)} + \tfrac{\tau\, i(1-\tau)}{D(\lambda)^2}\,\gamma_K\right]
\end{aligned} \tag{222}$$

Ignoring second order effects that would cancel out, the ratio of payroll to capital can be written as:

$$Z = \frac{(1-\beta)(p_B+\delta)}{\beta - \dfrac{\left(\tau^{\min} - \tau\,\dfrac{x(\lambda)}{D(\lambda)}\right)\gamma_L}{1-\tau-\left(\tau^{\min} - \tau\,\dfrac{x(\lambda)}{D(\lambda)}\right)}} \tag{223}$$

Note that

$$X(\lambda) = (1+\theta)(p_B+\delta) + \theta - (1+\theta)\delta,$$
$$D(\lambda) = (1+\theta)(p_B+\delta) + \theta - (1+\theta)\delta - i(1-\tau)$$

In terms of solving for cost of capital and AETR, we follow the following steps. For AETR, we first insert the profitability (p_B) in to equation 223. We then insert the value of $Z = \omega\lambda$ in to equation 220.

For cost of capital, we first guess the value of $\tilde{p}_B$, and insert the value in to equation 223. Then, we plug in the value of $Z = \omega\lambda$ into equation 218. We iterate until the right side of 218 equals the left side of equation 218.

3 Allowance for Corporate Equity/Capital

3.1 Without Pillar Two

Under an allowance for corporate capital, which we treat to be similar with allowance for corporate equity,the value of the firm is given by the following equation.

$$\begin{aligned} V_{\mathrm{DG}} = & \underbrace{-1}_{\text{purchase}} + \underbrace{\frac{1-\tau}{1+i}(p+\delta)(1+\theta)}_{\text{after-tax operating}} + \underbrace{\frac{(1-\delta)(1+\theta)}{1+i}}_{\text{sale proceeds}} \\ & + \underbrace{\sum_{t=0}^{\infty} \frac{\tau\phi(1-\phi)^t}{(1+i)^t}}_{\text{depr. of original investment}} \underbrace{- (1-\delta)(1+\theta) \sum_{t=1}^{\infty} \frac{\tau\phi(1-\phi)^{t-1}}{(1+i)^t}}_{\text{foregone allowances on sale}} \\ & + \underbrace{\frac{\tau i(1-\phi)}{1+i} \left(1 + \sum_{t=0}^{\infty} \frac{(1-\phi)^t \big[(1-\phi) - (1-\delta)(1+\theta)\big]}{(1+i)^{t+1}} \right)}_{\text{ACE term}} \end{aligned} \tag{224}$$

Note that the $\big[(1-\phi) - (1-\delta)(1+\theta)\big]$ term captures the claw back of ACE if the firm sales the asset with a capital gain. That is becasue the book value of equity would be negative. In other words, capital gains would result in a lower ACE. For instance, when inflation is zero, and economic depreciation and tax depreciation are similar, there is no capital gains. Therefore, the value function collapses to:

$$V_{\mathrm{DG}} = \underbrace{-1}_{\text{purchase}} + \underbrace{\frac{1-\tau}{1+r}(p+\delta)}_{\text{after-tax operating}} + \underbrace{\frac{(1-\delta)}{1+r}}_{\text{sale proceeds}} \tag{225}$$

$$+ \underbrace{\sum_{t=0}^{\infty} \frac{\tau\phi(1-\phi)^t}{(1+r)^t}}_{\text{depr. of original investment}} \underbrace{- (1-\delta) \sum_{t=1}^{\infty} \frac{\tau\phi(1-\phi)^{t-1}}{(1+r)^t}}_{\text{foregone allowances on sale}} \tag{226}$$

$$+ \underbrace{\frac{\tau r(1-\phi)}{1+r}}_{\text{ACE term}} \tag{227}$$

This can readily be simplified to show that

$$V_{\mathrm{DG}} = (1-\tau)(p+\delta) - (\delta + r)(1-\tau) \tag{228}$$

Which implies:

$$\tilde{p} = r \tag{229}$$

Note that equation 229 applies as long as the ACE term is $\frac{\tau i(1-\phi)}{1+i}\left(1+\sum_{t=0}^{\infty}\frac{(1-\phi)^t\left[(1-\phi)-(1-\delta)(1+\theta)\right]}{(1+i)^{t+1}}\right)$

What about the AETR? To show the AETR under ACE, let's go back to equation 224 and simplify it as follows:

$$\begin{aligned} V_{\text{DG}} = & -\frac{r+\delta}{1+r}+\frac{(1-\tau)(p+\delta)}{1+r}+\tau A-\frac{\tau A(1-\delta)}{1+r} \\ & +\underbrace{\frac{\tau i(1-\phi)(r+\delta)}{(i+\phi)(1+r)}}_{\text{ACE term}} \end{aligned} \tag{230}$$

using the fact that $A=\frac{\phi(1+i)}{\phi+i}$, we can simplify equation 230 as:

$$\begin{aligned} V_{\text{DG}} = & \frac{(1-\tau)(p+\delta)}{1+r}-\frac{r+\delta}{1+r}(1-\tau A) \\ & +\underbrace{\left[\frac{\tau(r+\delta)}{1+r}-\tau A\frac{r+\delta}{1+r}\right]}_{\text{ACE term}} \end{aligned} \tag{231}$$

Which further simplifies to:

$$V_{\text{DG}}=\frac{(1-\tau)(p+\delta)}{1+r}-\frac{(1-\tau)(r+\delta)}{1+r} \tag{232}$$

Using equation 232, we can express AETR under ACE as:

$$AETR=\frac{\frac{p-r}{1+r}-(1-\tau)\frac{p+\delta}{1+r}+(1-\tau)\frac{r+\delta}{1+r}}{\frac{p}{1+r}}=\tau\frac{p-r}{p} \tag{233}$$

3.2 With Pillar Two

3.2.1 ACE as QRTC

A. Equity Financing If the project is equity financed, the ACE under pillar two is equivalent to the CIT with a specific value of QRTC. The QRTC is

$\mu=\tau(1+\theta)(r+\delta)(1-A)$

Then, using equations 93 and 95, under a general CRS production function:

$$\tilde{p}_B=\frac{1}{1-\tau-\left(\tau^{\min}-\tau\,\xi^{\mu}\right)}\Bigg[(r+\delta)(1-\tau A)-\frac{\tau(1+\theta)(r+\delta)(1-A)}{1+\theta}$$

$$+\big(\tau^{\min} - \tau\,\xi^{\mu}\big)\left(\frac{\tau(1+\theta)(r+\delta)(1-A)}{1+\theta} + \frac{\theta}{1+\theta} - \delta - \frac{\gamma_K}{1+\theta} - \gamma_L\,\omega\,\lambda_B\right)\Bigg] - \delta \tag{234}$$

Which simplifies to:

$$\tilde{p}_B = \frac{1}{1-\tau-\big(\tau^{\min}-\tau\,\xi^{\mu}\big)}\Bigg[(r+\delta)(1-\tau) + \big(\tau^{\min}-\tau\,\xi^{\mu}\big)\left(\tau(r+\delta)(1-A) + \frac{\theta}{1+\theta} - \delta - \frac{\gamma_K}{1+\theta} - \gamma_L\,\omega\,\lambda_B\right)\Bigg] - \delta \tag{235}$$

The AETR:

$$\text{AETR} = \frac{\big[\tau + (\tau^{\min} - \tau\,\xi^{\mu})\big](p_B+\delta) - (r+\delta)\tau A - \dfrac{\tau(1+\theta)(r+\delta)(1-A)}{1+\theta}}{p_B} + \frac{\big(\tau^{\min}-\tau\,\xi^{\mu}\big)\Big\{\dfrac{\tau(1+\theta)(r+\delta)(1-A)}{1+\theta} + \dfrac{\theta}{1+\theta} - \delta - \dfrac{\gamma_K}{1+\theta} - \gamma_L\,\omega\,\lambda_B\Big\}}{p_B} \tag{236}$$

Which simplies to:

$$\text{AETR} = \frac{\left[\tau + (\tau^{\min} - \tau\xi^{\mu})\right](p_B+\delta) - \tau(r+\delta)}{p_B} + \frac{\big(\tau^{\min}-\tau\xi^{\mu}\big)\Big\{\tau(r+\delta)(1-A) + \frac{\theta}{1+\theta} - \delta - \frac{\gamma_K}{1+\theta} - \gamma_L\,\omega\,\lambda_B\Big\}}{p_B} \tag{237}$$

Note that

$$\begin{aligned}\xi^{\mu} &= \frac{(1+\theta)(p_B+\delta)+\theta-(1+\theta)\delta}{(1+\theta)(p_B+\delta)+\theta-(1+\theta)\delta+\tau(1+\theta)(r+\delta)(1-A)} \\ &= \frac{(p_B+\delta)+\frac{\theta}{1+\theta}-\delta}{(p_B+\delta)+\frac{\theta}{1+\theta}-\delta+\tau(r+\delta)(1-A)}\end{aligned} \tag{238}$$

Assuming a Cobb-Douglas production function will help parametrize $\omega\lambda$. As shown in the QRTC section, the terms involving $\dfrac{\tau\,\mu}{x(\lambda)+\mu}$ can safely be ignored, as they represent second-order effects.

Accordingly, the real wage–to–capital ratio, $Z = \omega\lambda$, can be expressed as:

$$Z = \frac{(1-\beta)(P_B+\delta)}{\beta - \dfrac{(\tau^{\min} - \tau\,\dfrac{x(\lambda)}{x(\lambda)+\mu})\gamma_L}{1-\tau-\left(\tau^{\min} - \tau\,\dfrac{x(\lambda)}{x(\lambda)+\mu}\right)}} \tag{239}$$

Note that $X(\lambda) = (1+\theta)(p_B+\delta) + \theta - (1+\theta)\delta$ and $\mu = \tau(1+\theta)(r+\delta)(1-A)$

In the case of AETR, we first plug in the relevant P_B in equation 239. Once that is solved, we use $Z = \omega\lambda$ in equation 237 and determine the AETR.

In the case of METR, we solve numerically. Step 1, guess $\tilde{p}_B$. We plug the initial $\tilde{p}_B$ in 239 to determine $Z = \omega\lambda$. We then plug that in equation 235 to check if that cost of capital is consistent with the equation and iterate until we arrive at the right cost of capital result.

B. Debt Financing

Binding top-up ($S^{G,\mu}(\lambda^B) > 0$).

$$\mathcal{V}(\lambda) = -1 + \frac{(1-\tau)\,(1+\theta)(p_B+\delta) + (1-\delta)(1+\theta)}{1+i} + \tau A - \frac{(1-\delta)(1+\theta)\,\tau A}{1+i} + \frac{\mu}{1+i} - \frac{\Theta(\lambda)\,\max\{S^{G,\mu}(\lambda), 0\}}{1+i} \tag{240}$$

let's denote $\dfrac{(1+\theta)(p_B+\delta)+\theta-(1+\theta)\delta}{(1+\theta)(p_B+\delta)+\theta-(1+\theta)\delta - i(1-\tau\phi) + \tau(1+\theta)(r+\delta)(1-A)} = \xi^{\mu_{debt}}$

Where $i(1-\tau\phi)$ represents the deduction, allowed under GLoBE, for interest paid on debt, and $\mu = \tau(1+\theta)(r+\delta)(1-A)$ represents the ACE allowance. Then,

$$\begin{aligned} \mathcal{V}(\lambda) = -1 + \tau A &+ \frac{(1-\tau)(1+\theta)(p_B+\delta) + (1-\delta)(1+\theta) - (1-\delta)(1+\theta)\tau A + \mu}{1+i} \\ &- \frac{\left(\tau^{\min} - \tau\,\xi^{\mu_{debt}}\right)}{1+i} \\ &\times \max\Big\{0,\ (1+\theta)(p_B+\delta) + \big[\mu + \theta - (1+\theta)\delta - i(1-\tau\phi) - \gamma_K\big] - \gamma_L\, W_1\lambda_B\Big\} \end{aligned} \tag{241}$$

$$\begin{aligned} \mathcal{V}(\lambda) = &\frac{(1-\tau)\,(p_B+\delta) + (1-\delta)}{1+r} - \frac{r+\delta}{1+r}(1-\tau) \\ &- \left(\tau^{\min} - \tau\,\xi^{\mu_{debt}}\right)\frac{\max\Big\{0,\ (p_B+\delta) + \Big[\tau(r+\delta)[1-A] + \frac{\theta}{1+\theta} - \delta - \frac{i(1-\tau\phi)}{1+\theta} - \frac{\gamma_K}{1+\theta}\Big] - \gamma_L\,\omega\lambda_B\Big\}}{1+r} \end{aligned}$$

$$\mathcal{V}(\lambda) = \frac{[1-\tau-(\tau^{min} - \tau\xi^{\mu_{debt}})]\,(p_B+\delta)}{1+r} - \frac{(r+\delta)(1-\tau)}{1+r}$$

$$-\frac{\left(\tau^{\min}-\tau\xi^{\mu_{debt}}\right)\left\{\left[\tau(r+\delta)[1-A]+\frac{\theta}{1+\theta}-\delta-\frac{i(1-\tau\phi)}{1+\theta}-\frac{\gamma_K}{1+\theta}\right]-\gamma_L\,\omega\lambda_B\right\}}{1+r} \tag{242}$$

Using equation 242 We can derive the cost of capital (hence METR) and AETR under ACE and pillar two for a debt financed project.

Setting equation 242 to zero:

$$\begin{aligned}\tilde{p}_B=&\frac{1}{1-\tau-\left(\tau^{\min}-\tau\,\xi^{\mu_{debt}}\right)}\Bigg[(r+\delta)(1-\tau)\\&+\left(\tau^{\min}-\tau\,\xi^{\mu_{debt}}\right)\left(\tau(r+\delta)[1-A]+\frac{\theta}{1+\theta}-\delta-\frac{i(1-\tau\phi)}{1+\theta}-\frac{\gamma_K}{1+\theta}-\gamma_L\,\omega\lambda_B\right)\Bigg]-\delta\end{aligned} \tag{243}$$

and

$$\begin{aligned}\text{AETR}=&\frac{\left[\tau+\left(\tau^{\min}-\tau\,\xi^{\mu_{\text{debt}}}\right)\right](p_B+\delta)-\tau(r+\delta)}{p_B}\\&+\frac{\left(\tau^{\min}-\tau\,\xi^{\mu_{\text{debt}}}\right)\left[\tau(r+\delta)(1-A)+\frac{\theta}{1+\theta}-\delta-\frac{i(1-\tau\phi)}{1+\theta}-\frac{\gamma_K}{1+\theta}-\gamma_L\,\omega\,\lambda_B\right]}{p_B}\end{aligned} \tag{244}$$

Assuming a Cobb-Douglas production function will help parametrize $\omega\lambda$. Compared to the case of equity financed project, the optimal labor condition changes since deduction for interest enters the top-up rate. We follow the following steps:

Note that:

$$X(\lambda)=(1+\theta)(p_B+\delta)+\theta-(1+\theta)\delta,$$
$$\mu=\tau(1+\theta)(r+\delta)(1-A)$$

Using

$$a_Z\equiv\beta\,\frac{\tau\left(\mu-i(1-\tau\phi)\right)}{\left(x(\lambda)-i(1-\tau\phi)+\mu\right)^2}\,\gamma_L(1+\theta), \tag{245}$$

$$\begin{aligned}b_Z\equiv&-(1-\beta)(P_B+\delta)\,\frac{\tau\left(\mu-i(1-\tau\phi)\right)}{\left(x(\lambda)+\mu\right)^2}\,\gamma_L(1+\theta)\\&-\beta\left[(1-\tau)-\left(\tau^{\min}-\tau\,\frac{x(\lambda)}{x(\lambda)-i(1-\tau\phi)+\mu}\right)-\frac{\tau\left(\mu-i(1-\tau\phi)\right)}{\left(x(\lambda)-i(1-\tau\phi)+\mu\right)^2}\gamma_K\right]\\&+\left(\tau^{\min}-\tau\,\frac{x(\lambda)}{x(\lambda)-i(1-\tau\phi)+\mu}\right)\gamma_L,\end{aligned} \tag{246}$$

$$c_Z \equiv (1-\beta)(P_B+\delta)\left[(1-\tau) - \left(\tau^{\min} - \tau \frac{x(\lambda)}{x(\lambda) - i(1-\tau\phi) + \mu}\right) - \frac{\tau\left(\mu - i(1-\tau\phi)\right)}{\left(x(\lambda) - i(1-\tau\phi) + \mu\right)^2}\gamma_K\right] \tag{247}$$

and

$$a_Z Z^2 + b_Z Z + c_Z = 0, \tag{248}$$

and the solution for $Z = \omega\lambda$ is

$$Z = \frac{-\,b_Z \ \pm\ \sqrt{b_Z^2 - 4\,a_Z\,c_Z}}{2\,a_Z} \tag{249}$$

Similar to the case of equity financed project, we ignore the second order effects (terms that involve $\dfrac{\tau\left(\mu - i(1-\tau\phi)\right)}{x(\lambda)+\mu}$.

Accordingly, the real wage–to–capital ratio, $Z = \omega\lambda$, can be expressed as:

$$Z = \frac{(1-\beta)(P_B+\delta)}{\beta - \dfrac{(\tau^{\min} - \tau \dfrac{x(\lambda)}{x(\lambda) - i(1-\tau\phi) + \mu})\gamma_L}{1 - \tau - \left(\tau^{\min} - \tau \dfrac{x(\lambda)}{x(\lambda) - i(1-\tau\phi) + \mu}\right)}} \tag{250}$$

Note that $X(\lambda) = (1+\theta)(p_B+\delta) + \theta - (1+\theta)\delta$ and $\mu = \tau(1+\theta)(r+\delta)(1-A)$

In the case of AETR, we first plug in the relevant P_B in equation 250. Once that is solved, we use $Z = \omega\lambda$ in equation 244 and determine the AETR.

In the case of METR, we solve numerically. Step 1, guess $\tilde{p}_B$. We plug the initial $\tilde{p}_B$ in 250 to determine $Z = \omega\lambda$. We then plug that in equation 242 to check if that cost of capital is consistent with the equation and iterate until we arrive at the right cost of capital result.

3.2.2 ACE as NQRTC

A. Equity Financing If the project is equity financed, the ACE under pillar two is equivalent to the CIT with a specific value of NQRTC. The NQRTC is

$\mu = \tau(1+\theta)(r+\delta)(1-A)$

Then, using equation 139 and 141, under a general CRS production function:

$$\tilde{p}_B = \frac{1}{1 - \tau - \left(\tau^{\min} - (\tau - \xi^{\mu_{nqrtc}})\right)}\left[(r+\delta)(1-\tau A) - \frac{\tau(1+\theta)(r+\delta)(1-A)}{1+\theta}\right.$$

$$+\big(\tau^{\min} - (\tau - \xi^{\mu_{nqrtc}})\big)\left(\frac{\theta}{1+\theta} - (r+\delta)A - \frac{\gamma_K}{1+\theta} - \gamma_L\,\omega\,\lambda_B\right)\Bigg] - \delta \tag{251}$$

Further simplifying,

$$\tilde{p}_B = \frac{1}{1 - \tau^{\min} - \xi^{\mu_{nqrtc}})}\Bigg[(r+\delta)(1-\tau)$$
$$+\big(\tau^{\min} - \tau + \xi^{\mu_{nqrtc}}\big)\left(\frac{\theta}{1+\theta} - \delta - \frac{\gamma_K}{1+\theta} - \gamma_L\,\omega\,\lambda_B\right)\Bigg] - \delta \tag{252}$$

Note that since $\xi^{\mu_{nqrtc}}$ is also a function of $\tilde{p}_B$, equation 139 is non-linear and can only be solved numerically.

The AETR:

$$\text{AETR} = \frac{\left[\tau + (\tau^{\min} - (\tau - \xi^{\mu_{nqrtc}}))\right](p_B+\delta) - (r+\delta)\tau A - \frac{\tau(1+\theta)(r+\delta)(1-A)}{1+\theta}}{p_B}$$
$$+ \frac{\big(\tau^{\min} - (\tau - \xi^{\mu_{nqrtc}})\big)\left\{\frac{\theta}{1+\theta} - (r+\delta)A - \frac{\gamma_K}{1+\theta} - \gamma_L\,\omega\,\lambda_B\right\}}{p_B} \tag{253}$$

Further simplifying:

$$\text{AETR} = \frac{\left[\tau^{\min} + \xi^{\mu_{nqrtc}})\right]\left[p_B+\delta\right] - (r+\delta)\tau}{p_B}$$
$$+ \frac{\big(\tau^{\min} - \tau + \xi^{\mu_{nqrtc}}\big)\left\{\frac{\theta}{1+\theta} - \delta - \frac{\gamma_K}{1+\theta} - \gamma_L\,\omega\,\lambda_B\right\}}{p_B} \tag{254}$$

Note that: $\dfrac{\tau(1+\theta)(r+\delta)(1-A)}{(1+\theta)(p_B+\delta) + \theta - (1+\theta)\delta} = \xi^{\mu_{nqrtc}}$

Assuming a Cobb-Douglas production function will help parametrize $\omega\lambda$. Compared to the case of equity financed project, the optimal labor condition changes since deduction for interest enters the top-up rate. We follow the following steps:

$$d_B \equiv d(\lambda^{\text{B}}) = (1+\theta)(P_B+\delta) + \theta - (1+\theta)\delta, \tag{255}$$

$$a_Z = \beta\,\frac{\tau\,\mu}{d_B^2}\,\gamma_L(1+\theta), \tag{256}$$

$$b_Z = -(1-\beta)(P_B+\delta)\,\frac{\tau\,\mu}{d_B^2}\,\gamma_L(1+\theta) - \beta\left(1 - \tau^{\min} - \frac{\tau\,\mu}{d_B^2}\,\gamma_K\right) + \left(\tau^{\min} - \tau + \tau\,\frac{\mu}{d_B}\right)\gamma_L, \tag{257}$$

$$c_Z = (1-\beta)(P_B+\delta)\left[1-\tau^{\min}-\frac{\tau\,\mu}{d_B^2}\,\gamma_K\right], \tag{258}$$

$$Z = \omega\,\lambda^{\mathrm{B}} \tag{259}$$

$$= \frac{-\,b_Z \pm \sqrt{b_Z^2 - 4a_Z c_Z}}{2a_Z} \tag{260}$$

Ignoring second order effects (i.e., terms that involve $\frac{\tau\,\mu}{d_B}$),

Accordingly, the real wage–to–capital ratio, $Z = \omega\lambda$, can be expressed as:

$$Z = \frac{(1-\beta)(P_B+\delta)}{\beta - \frac{\tau^{\min}-\tau}{1-\tau^{\min}}\gamma_L} \tag{261}$$

Note that $X(\lambda) = (1+\theta)(p_B+\delta)+\theta-(1+\theta)\delta$ and $\mu = \tau(1+\theta)(r+\delta)(1-A)$

In the case of AETR, we first plug in the relevant P_B in equation 261. Once that is solved, we use $Z = \omega\lambda$ in equation 254 and determine the AETR.

In the case of METR, we solve numerically. Step 1, guess $\tilde{p}_B$. We plug the initial $\tilde{p}_B$ in 261 to determine $Z = \omega\lambda$. We then plug that in equation 252 to check if that cost of capital is consistent with the equation and iterate until we arrive at the right cost of capital result.

B. Debt Financing If the project is equity financed, the ACE under pillar two is equivalent to the CIT with a specific value of NQRTC. The NQRTC is

$\mu = \tau(1+\theta)(r+\delta)(1-A)$

For the formulas see the next section (summary).

Summary Containing all Relevant Formulas

A CIT

A.1 With out tax credit

A.1.1 Equity

No top up

$$\tilde{p} = \frac{(r+\delta)(1-\tau A)}{1-\tau} - \delta$$
$$AETR = \frac{\tau[(p+\delta)-(r+\delta)A]}{p}$$

With top up

$$\tilde{p}_B = \frac{(r+\delta)(1-\tau A) + (\tau^{\min}-\tau)\left[\frac{\theta}{1+\theta} - \delta - \frac{\gamma_K}{1+\theta}\right]}{(1-\tau^{\min}) + (\tau^{\min}-\tau)\left(\gamma_L \frac{1-\beta}{\beta-\rho\gamma_L}\right)} - \delta$$

$$AETR = \frac{1}{p_B}\left((p_B+\delta)\left[\tau^{min} - (\tau^{\min}-\tau)\,\frac{\gamma_L(1-\beta)}{\beta-\rho\gamma_L}\right] - (r+\delta)\tau A + (\tau^{\min}-\tau)\left[\frac{\theta}{1+\theta} - \delta - \frac{\gamma_K}{1+\theta}\right]\right)$$

Where $\rho = \frac{\tau^{min}-\tau}{1-\tau^{min}}$

and

$$Z = \omega\,\lambda_B = \frac{(1-\beta)\,(p_B+\delta)}{\beta - \dfrac{\tau^{\min}-\tau}{1-\tau^{\min}}\gamma_L}$$

A.1.2 Debt

Without top up

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

$$AETR = \tau\,\frac{p+\delta-(r+\delta)A - \dfrac{i(1-\tau\phi)}{1+\theta}}{p}$$

With top up

$$\tilde{p}_B = \frac{(r+\delta)(1-\tau A) - \tau\frac{i(1-\tau\phi)}{1+\theta} + (\tau^{\min}-\tau)\left[\frac{\theta}{1+\theta} - \delta - \frac{i(1-\tau\phi)}{1+\theta} - \frac{\gamma_K}{1+\theta}\right]}{(1-\tau^{\min}) + (\tau^{\min}-\tau)\left(\gamma_L\,\frac{1-\beta}{\beta-\rho\gamma_L}\right)} - \delta$$

$$AETR = \frac{1}{p_B}\Bigg((p_B+\delta)\left[\tau^{min} - (\tau^{\min}-\tau)\,\frac{\gamma_L(1-\beta)}{\beta-\theta\gamma_L}\right] - (r+\delta)\tau A - \tau\frac{i(1-\tau\phi)}{1+\theta}$$
$$+ (\tau^{\min}-\tau)\left[\frac{\theta}{1+\theta} - \delta - \frac{i(1-\tau\phi)}{1+\theta} - \frac{\gamma_K}{1+\theta}\right]\Bigg)$$

Where $\theta = \frac{\tau^{min}-\tau}{1-\tau^{min}}$ and

$$Z = \omega\,\lambda_B = \frac{(1-\beta)\,(p_B+\delta)}{\beta - \dfrac{\tau^{\min}-\tau}{1-\tau^{\min}}\gamma_L}$$

A.2 QRTC

A.2.1 Equity Financed

Without top up

$$\tilde{p} = \frac{(r+\delta)\,(1-\tau A)\;-\;\dfrac{\mu}{1+\theta}}{1-\tau} - \delta$$
$$AETR = \frac{\tau[(p+\delta)-(r+\delta)A] - \frac{\mu}{1+\theta}}{p}$$

With top up

$$\tilde{p}_B = \frac{1}{1-\tau-\left(\tau^{\min}-\tau\,\xi^{\mu}\right)}\Bigg[(r+\delta)(1-\tau A) - \frac{\mu}{1+\theta}$$
$$+\left(\tau^{\min}-\tau\,\xi^{\mu}\right)\left(\frac{\mu}{1+\theta} + \frac{\theta}{1+\theta} - \delta - \frac{\gamma_K}{1+\theta} - \gamma_L\,\omega\,\lambda_B\right)\Bigg] - \delta$$

$$\text{AETR} = \frac{\left[\tau + (\tau^{\min}-\tau\xi^{\mu})\right](p_B+\delta) - (r+\delta)\tau A - \frac{\mu}{1+\theta}}{p_B}$$
$$+ \frac{\left(\tau^{\min}-\tau\xi^{\mu}\right)\left\{\frac{\mu}{1+\theta} + \frac{\theta}{1+\theta} - \delta - \frac{\gamma_K}{1+\theta} - \gamma_L\,\omega\,\lambda_B\right\}}{p_B}$$

The real wage–to–capital ratio, $Z = \omega\lambda$, for a cobb-douglas produciton function, is:

$$Z = \frac{(1-\beta)(P_B+\delta)}{\beta - \frac{(\tau^{\min} - \tau \frac{x(\lambda)}{x(\lambda)+\mu})\gamma_L}{1-\tau-\left(\tau^{\min} - \tau \frac{x(\lambda)}{x(\lambda)+\mu}\right)}}$$

Where:

$$X(\lambda) = (1+\theta)(p_B+\delta) + \theta - (1+\theta)\delta$$
$$D(\lambda) = (1+\theta)(p_B+\delta) + \theta - (1+\theta)\delta + \mu$$
$$\xi^{\mu} = \frac{(1+\theta)(p_B+\delta) + \theta - (1+\theta)\delta}{(1+\theta)(p_B+\delta) + \theta - (1+\theta)\delta + \mu}$$

In the case of AETR, we first plug in the relevant P_B in the the payroll to capital ratio equation. Once that is solved, we use $Z = \omega\lambda$ in determine the AETR by plugging the value of Z in the AETR equation.

In the case of METR, we solve numerically. Step 1, guess $\tilde{p}_B$. We plug the initial $\tilde{p}_B$ in the the payroll to capital ratio equation to determine $Z = \omega\lambda$. We then plug that in the cost of capital equation to check if that cost of capital is consistent with the equation and iterate until we arrive at the right cost of capital result.

A.2.2 Debt Financed projects

Without top up

$$\tilde{p} = \frac{(r+\delta)(1-\tau A) \; - \; \frac{\mu}{1+\theta} \; - \; \frac{\tau i(1-\tau\phi)}{1+\theta}}{1-\tau} - \delta$$

$$AETR = \frac{\tau\Big[(p+\delta) - (r+\delta)A \; - \; \frac{i(1-\tau\phi)}{1+\theta}\Big] - \frac{\mu}{1+\theta}}{p}$$

With top up

$$\tilde{p}_B = \frac{1}{1-\tau-\left(\tau^{\min} - \tau\,\xi^{\mu}\right)}\Bigg[(r+\delta)(1-\tau A) - \frac{\mu}{1+\theta} - \tau\frac{i(1-\tau\phi)}{1+\theta}$$
$$+\left(\tau^{\min} - \tau\,\xi^{\mu}\right)\left(\frac{\mu}{1+\theta} + \frac{\theta}{1+\theta} - \delta - \frac{i(1-\tau\phi)}{1+\theta} - \frac{\gamma_K}{1+\theta} - \gamma_L\,\omega\,\lambda_B\right)\Bigg] - \delta$$

$$\text{AETR} = \frac{\left[\tau + (\tau^{\min} - \tau\xi^{\mu})\right](p_B + \delta) - (r+\delta)\tau A - \frac{\mu}{1+\theta} - \tau\frac{i(1-\tau\phi)}{1+\theta}}{p_B} + \frac{\left(\tau^{\min} - \tau\xi^{\mu}\right)\left\{\frac{\mu}{1+\theta} + \frac{\theta}{1+\theta} - \delta - \frac{i(1-\tau\phi)}{1+\theta} - \frac{\gamma_K}{1+\theta} - \gamma_L\,\omega\,\lambda_B\right\}}{p_B}$$

The real wage–to–capital ratio, $Z = \omega\lambda$, for a cobb-douglas produciton function, is:

$$Z = \frac{(1-\beta)(P_B + \delta)}{\beta - \frac{(\tau^{\min} - \tau\,\frac{x(\lambda)}{x(\lambda)+\mu})\gamma_L}{1 - \tau - \left(\tau^{\min} - \tau\,\frac{x(\lambda)}{x(\lambda)+\mu}\right)}}$$

Where:

$$X(\lambda) = (1+\theta)(p_B + \delta) + \theta - (1+\theta)\delta - i(1-\tau\phi)$$
$$D(\lambda) = (1+\theta)(p_B + \delta) + \theta - (1+\theta)\delta - i(1-\tau\phi) + \mu$$
$$\xi^{\mu} = \frac{(1+\theta)(p_B + \delta) + \theta - (1+\theta)\delta - i(1-\tau\phi)}{(1+\theta)(p_B + \delta) + \theta - (1+\theta)\delta - i(1-\tau\phi) + \mu}$$

In the case of AETR, we first plug in the relevant P_B in the the payroll to capital ratio equation. Once that is solved, we use $Z = \omega\lambda$ in determine the AETR by plugging the value of Z in the AETR equation.

In the case of METR, we solve numerically. Step 1, guess $\tilde{p}_B$. We plug the initial $\tilde{p}_B$ in the the payroll to capital ratio equation to determine $Z = \omega\lambda$. We then plug that in the cost of capital equation to check if that cost of capital is consistent with the equation and iterate until we arrive at the right cost of capital result.

A.3 NQRTC

A.3.1 Equity Finance

Without top up

$$\tilde{p} = \frac{(r+\delta)(1-\tau A) \; - \; \frac{\mu}{1+\theta}}{1-\tau} - \delta$$
$$AETR = \frac{\tau[(p+\delta) - (r+\delta)A] - \frac{\mu}{1+\theta}}{p}$$

With a top up

$$\tilde{p}_B = \frac{1}{1-\tau^{\min}-\xi^{\mu_{nqrtc}}}\Bigg[(r+\delta)(1-\tau A) - \frac{\mu}{1+\theta}$$
$$+\big(\tau^{\min}-\tau+\xi^{\mu_{nqrtc}}\big)\left(\frac{\theta}{1+\theta} - \delta - \frac{\gamma_K}{1+\theta} - \gamma_L\,\omega\,\lambda_B\right)\Bigg] - \delta$$

$$\text{AETR} = \frac{1}{p_B}\Bigg\{\Big[\tau^{\min}+\xi^{\mu_{nqrtc}}\Big]\,(p_B+\delta) - (r+\delta)\,\tau A - \frac{\mu}{1+\theta}$$
$$+\,\big(\tau^{\min}-\tau+\xi^{\mu_{nqrtc}}\big)\Big[\frac{\theta}{1+\theta} - \delta - \frac{\gamma_K}{1+\theta} - \gamma_L\,\omega\,\lambda_B\Big]\Bigg\}$$

The ratio of payroll to capital, $Z = \omega\lambda$:

$$Z = \frac{(1-\beta)(P_B+\delta)}{\beta - \dfrac{(\tau^{\min}-\tau)\,\gamma_L}{1-\tau^{\min}}}$$

Where:

$$\xi^{\mu_{nqrtc}} = \frac{\mu}{(1+\theta)(p_B+\delta)+\theta-(1+\theta)\delta}$$

[1]

A.3.2 Debt Finance

Without top up

$$\tilde{p} = \frac{(r+\delta)\,(1-\tau A)\ -\ \dfrac{\mu}{1+\theta}\ -\ \dfrac{\tau i(1-\tau\phi)}{1+\theta}}{1-\tau} - \delta$$

$$AETR = \frac{\tau\Big[(p+\delta)-(r+\delta)A\ -\ \dfrac{i(1-\tau\phi)}{1+\theta}\Big] - \frac{\mu}{1+\theta}}{p}$$

With a top up

$$\tilde{p}_B = \frac{1}{1-\tau^{\min}-\xi^{\mu_{nqrtc}})}\Bigg[(r+\delta)(1-\tau A) - \tau\frac{i(1-\tau\phi)}{1+\theta} - \frac{\mu}{1+\theta}$$
$$+\big(\tau^{\min}-\tau+\xi^{\mu_{nqrtc}}\big)\left(\frac{\theta}{1+\theta} - \delta - \frac{i(1-\tau\phi)}{1+\theta} - \frac{\gamma_K}{1+\theta} - \gamma_L\,\omega\,\lambda_B\right)\Bigg] - \delta$$

[1] Note that the above formulation accommodates tax credits that may or may not depend on the domestic tax. If the tax credit is dependent on the domestic tax, then the definition of μ already contains the tax rate itself. For instance, in the case of ACE, as we will show later, $\mu = \tau(1+\theta)(r+\delta)(1-A)$

$$\text{AETR} = \frac{1}{p_B}\Bigg\{\left[\tau^{\min} + \xi^{\mu_{nqrtc}})\right](p_B+\delta) - (r+\delta)\,\tau A - \frac{\mu}{1+\theta} - \tau\frac{i(1-\tau\phi)}{1+\theta}$$
$$+\left(\tau^{\min} - \tau + \xi^{\mu_{nqrtc}}\right)\left[\frac{\theta}{1+\theta} - \delta - \frac{i(1-\tau\phi)}{1+\theta} - \frac{\gamma_K}{1+\theta} - \gamma_L\,\omega\,\lambda_B\right]\Bigg\}$$

The ratio of payroll to capital, $Z = \omega\lambda$:

$$Z = \frac{(1-\beta)(P_B+\delta)}{\beta - \dfrac{(\tau^{\min}-\tau)\,\gamma_L}{1-\tau^{\min}}}$$

Where:

$$\xi^{\mu_{nqrtc}} = \frac{\mu}{(1+\theta)(p_B+\delta)+\theta-(1+\theta)\delta - i(1-\tau\phi)}$$

B Cash-Flow Tax

B.1 Equity Finance

Without top up

$$\tilde{p} = r$$
$$AETR = \tau\frac{p-r}{p}$$

With top up

$$\tilde{p}_B = \frac{(r+\delta)(1-\tau) + (\tau^{\min}-\tau)\left[\frac{\theta}{1+\theta} - \delta - \frac{\gamma_K}{1+\theta}\right]}{(1-\tau^{\min}) + (\tau^{\min}-\tau)\left(\gamma_L\,\frac{1-\beta}{\beta-\rho\gamma_L}\right)} - \delta$$

$$AETR = \frac{1}{p_B}\left((p_B+\delta)\left[\tau^{min} - (\tau^{\min}-\tau)\,\tfrac{\gamma_L(1-\beta)}{\beta-\rho\gamma_L}\right] - (r+\delta)\tau + (\tau^{\min}-\tau)\left[\frac{\theta}{1+\theta} - \delta - \frac{\gamma_K}{1+\theta}\right]\right)$$

Where $\rho = \frac{\tau^{min}-\tau}{1-\tau^{min}}$

B.2 Debt Finance

Without top up

$$\tilde{p} = r$$
$$AETR = \tau\frac{p-r}{p}$$

With top up

$$\tilde{p}_B = \frac{1}{1-\tau-\left(\tau^{\min}-\tau\,\xi\mu_{cft}\right)}\Bigg[(r+\delta)(1-\tau)$$
$$+\left(\tau^{\min}-\tau\,\xi^{\mu_{cft}}\right)\left(\frac{\theta}{1+\theta}-\delta-\frac{i(1-\tau)}{1+\theta}-\frac{\gamma_K}{1+\theta}-\gamma_L\,\omega\,\lambda_B\right)\Bigg]-\delta$$

$$\text{AETR} = \frac{\left[\tau+(\tau^{\min}-\tau\xi^{\mu_{cft}})\right](p_B+\delta)-(r+\delta)\tau}{p_B}$$
$$+\frac{\left(\tau^{\min}-\tau\xi^{\mu_{cft}}\right)\left\{\frac{\theta}{1+\theta}-\delta-\frac{i(1-\tau)}{1+\theta}-\frac{\gamma_K}{1+\theta}-\gamma_L\,\omega\,\lambda_B\right\}}{p_B}$$

$$Z=\omega\lambda_B=\frac{(1-\beta)(p_B+\delta)}{\beta-\dfrac{(\tau^{\min}-\tau\,\dfrac{x(\lambda)}{D(\lambda)})\gamma_L}{1-\tau-\left(\tau^{\min}-\tau\,\dfrac{x(\lambda)}{D(\lambda)}\right)}} \tag{262}$$

Note that

$$X(\lambda)=(1+\theta)(p_B+\delta)+\theta-(1+\theta)\delta,$$
$$D(\lambda)=(1+\theta)(p_B+\delta)+\theta-(1+\theta)\delta-i(1-\tau),$$
$$\xi^{\mu_{cft}}=\frac{(1+\theta)(p_B+\delta)+\theta-(1+\theta)\delta}{(1+\theta)(p_B+\delta)+\theta-(1+\theta)\delta-i(1-\tau)}$$

C Allowance for Equity (ACE)

C.1 ACE considered as QRTC

In this case, the credit is : $\mu=\tau(1+\theta)(r+\delta)(1-A)$

C.1.1 Equity Finance

Without top up

$$\tilde{p}=\frac{(r+\delta)\,(1-\tau A)\;-\;\dfrac{\tau(1+\theta)(r+\delta)(1-A)}{1+\theta}}{1-\tau}-\delta\Rightarrow\tilde{p}=r$$

$$AETR=\frac{\tau[(p+\delta)-(r+\delta)A]-\frac{\tau(1+\theta)(r+\delta)(1-A)}{1+\theta}}{p}\Rightarrow AETR=\tau\frac{p-r}{p}$$

With top up

$$\tilde{p}_B = \frac{1}{1-\tau-\left(\tau^{\min}-\tau\,\xi^{\mu}\right)}\Bigg[(r+\delta)(1-\tau) + \left(\tau^{\min}-\tau\,\xi^{\mu}\right)\left(\tau(r+\delta)(1-A)+\frac{\theta}{1+\theta}-\delta-\frac{\gamma_K}{1+\theta}-\gamma_L\,\omega\,\lambda_B\right)\Bigg]-\delta$$

$$\text{AETR} = \frac{\left[\tau+\left(\tau^{\min}-\tau\xi^{\mu}\right)\right](p_B+\delta)-\tau(r+\delta)}{p_B} + \frac{\left(\tau^{\min}-\tau\xi^{\mu}\right)\left\{\tau(r+\delta)(1-A)+\frac{\theta}{1+\theta}-\delta-\frac{\gamma_K}{1+\theta}-\gamma_L\,\omega\,\lambda_B\right\}}{p_B}$$

Note that

$$\xi^{\mu} = \frac{(1+\theta)(p_B+\delta)+\theta-(1+\theta)\delta}{(1+\theta)(p_B+\delta)+\theta-(1+\theta)\delta+\tau(1+\theta)(r+\delta)(1-A)} = \frac{(p_B+\delta)+\frac{\theta}{1+\theta}-\delta}{(p_B+\delta)+\frac{\theta}{1+\theta}-\delta+\tau(r+\delta)(1-A)}$$

and

$$Z = \omega\lambda_B = \frac{(1-\beta)(P_B+\delta)}{\beta-\dfrac{(\tau^{\min}-\tau\,\dfrac{x(\lambda)}{x(\lambda)+\mu})\gamma_L}{1-\tau-\left(\tau^{\min}-\tau\,\dfrac{x(\lambda)}{x(\lambda)+\mu}\right)}} \tag{263}$$

Note that $X(\lambda)=(1+\theta)(p_B+\delta)+\theta-(1+\theta)\delta$ and $\mu=\tau(1+\theta)(r+\delta)(1-A)$

C.1.2 Debt Finance

Without top up

$$\tilde{p} = \frac{(r+\delta)\,(1-\tau A)\;-\;\dfrac{\tau(1+\theta)(r+\delta)(1-A)}{1+\theta}}{1-\tau}-\delta \Rightarrow \tilde{p}=r$$

$$AETR = \frac{\tau[(p+\delta)-(r+\delta)A]-\frac{\tau(1+\theta)(r+\delta)(1-A)}{1+\theta}}{p} \Rightarrow AETR = \tau\frac{p-r}{p}$$

With top up

$$\tilde{p}_B = \frac{1}{1-\tau-\left(\tau^{\min}-\tau\,\xi^{\mu_{debt}}\right)}\Bigg[(r+\delta)(1-\tau)$$
$$+\left(\tau^{\min}-\tau\,\xi^{\mu_{debt}}\right)\left(\tau(r+\delta)[1-A]+\frac{\theta}{1+\theta}-\delta-\frac{i(1-\tau\phi)}{1+\theta}-\frac{\gamma_K}{1+\theta}-\gamma_L\,\omega\lambda_B\right)\Bigg]-\delta$$

and

$$\text{AETR} = \frac{\left[\tau+(\tau^{\min}-\tau\,\xi^{\mu_{\text{debt}}})\right](p_B+\delta)-\tau(r+\delta)}{p_B}$$
$$+\frac{\left(\tau^{\min}-\tau\,\xi^{\mu_{\text{debt}}}\right)\left[\tau(r+\delta)(1-A)+\frac{\theta}{1+\theta}-\delta-\frac{i(1-\tau\phi)}{1+\theta}-\frac{\gamma_K}{1+\theta}-\gamma_L\,\omega\,\lambda_B\right]}{p_B}$$

$$Z=\omega\lambda_B=\frac{(1-\beta)(P_B+\delta)}{\beta-\dfrac{(\tau^{\min}-\tau\,\dfrac{x(\lambda)}{x(\lambda)-i(1-\tau\phi)+\mu})\gamma_L}{1-\tau-\left(\tau^{\min}-\tau\,\dfrac{x(\lambda)}{x(\lambda)-i(1-\tau\phi)+\mu}\right)}}$$

Note that $X(\lambda)=(1+\theta)(p_B+\delta)+\theta-(1+\theta)\delta$ and $\mu=\tau(1+\theta)(r+\delta)(1-A)$

and $\dfrac{(1+\theta)(p_B+\delta)+\theta-(1+\theta)\delta}{(1+\theta)(p_B+\delta)+\theta-(1+\theta)\delta-i(1-\tau\phi)+\tau(1+\theta)(r+\delta)(1-A)}=\xi^{\mu_{debt}}$

C.2 ACE considered as NQRTC

C.2.1 Equity Finance

Without top up

$$\tilde{p}=\frac{(r+\delta)\,(1-\tau A)\;-\;\dfrac{\tau(1+\theta)(r+\delta)(1-A)}{1+\theta}}{1-\tau}-\delta\Rightarrow\tilde{p}=r$$

$$AETR=\frac{\tau[(p+\delta)-(r+\delta)A]-\frac{\tau(1+\theta)(r+\delta)(1-A)}{1+\theta}}{p}\Rightarrow AETR=\tau\frac{p-r}{p}$$

With top up

$$\tilde{p}_B=\frac{1}{1-\tau^{\min}-\xi^{\mu_{nqrtc}}}\Bigg[(r+\delta)(1-\tau)$$
$$+\left(\tau^{\min}-\tau+\xi^{\mu_{nqrtc}}\right)\left(\frac{\theta}{1+\theta}-\delta-\frac{\gamma_K(1-\phi)}{1+\theta}-\gamma_L\,\omega\,\lambda_B\right)\Bigg]-\delta$$

$$\text{AETR} = \frac{\left[\tau^{\min} + \xi^{\mu_{nqrtc}}\right](p_B + \delta) - (r+\delta)\tau}{p_B} + \frac{\left(\tau^{\min} - \tau + \xi^{\mu_{nqrtc}}\right)\left\{\frac{\theta}{1+\theta} - \delta - \frac{\gamma_K}{1+\theta} - \gamma_L\,\omega\,\lambda_B\right\}}{p_B}$$

Note that: $\dfrac{\tau(1+\theta)(r+\delta)(1-A)}{(1+\theta)(p_B+\delta)+\theta-(1+\theta)\delta} = \xi^{\mu_{nqrtc}}$

and

$$Z = \frac{(1-\beta)(P_B+\delta)}{\beta - \dfrac{(\tau^{\min}-\tau)\gamma_L}{1-\tau^{\min}}}$$

Note that $X(\lambda) = (1+\theta)(p_B+\delta)+\theta-(1+\theta)\delta$ and $\mu = \tau(1+\theta)(r+\delta)(1-A)$

C.2.2 Debt Finance

Without top up

$$\tilde{p} = \frac{(r+\delta)(1-\tau A) \; - \; \dfrac{\tau(1+\theta)(r+\delta)(1-A)}{1+\theta}}{1-\tau} - \delta \Rightarrow \tilde{p} = r$$

$$AETR = \frac{\tau[(p+\delta)-(r+\delta)A] - \frac{\tau(1+\theta)(r+\delta)(1-A)}{1+\theta}}{p} \Rightarrow AETR = \tau\frac{p-r}{p}$$

With a top up

$$\tilde{p}_B = \frac{1}{1-\tau-\left[\tau^{\min} - \left(\tau\frac{X(\lambda)}{D(\lambda)} - \xi^{\mu_{nqrtc}}\right)\right]}\Bigg[(r+\delta)(1-\tau) + \left(\tau^{\min} - \left(\tau\frac{X(\lambda)}{D(\lambda)} - \xi^{\mu_{nqrtc}}\right)\right)\left(\frac{\theta}{1+\theta} - \delta - \frac{i(1-\tau\phi)}{1+\theta} - \frac{\gamma_K}{1+\theta} - \gamma_L\,\omega\,\lambda_B\right)\Bigg] - \delta$$

$$\text{AETR} = \frac{1}{p_B}\Bigg\{\left[\tau + (\tau^{\min} - (\tau\frac{X(\lambda)}{D(\lambda)} - \xi^{\mu_{nqrtc}})\right](p_B+\delta) - (r+\delta)\,\tau + \left(\tau^{\min} - (\tau\frac{X(\lambda)}{D(\lambda)} - \xi^{\mu_{nqrtc}})\right)\left[\frac{\theta}{1+\theta} - \delta - \frac{i(1-\tau\phi)}{1+\theta} - \frac{\gamma_K}{1+\theta} - \gamma_L\,\omega\,\lambda_B\right]\Bigg\}$$

The ratio of payroll to capital, $Z = \omega\lambda$:

$$Z = \frac{(1-\beta)(P_B+\delta)}{\beta - \dfrac{(\tau^{\min} - \tau\frac{X(\lambda)}{D(\lambda)})\,\gamma_L}{1-\tau-(\tau^{\min} - \tau\frac{X(\lambda)}{D(\lambda)})}}$$

Where:

$$\xi^{\mu_{nqrtc}} = \frac{\tau(1+\theta)(1+\delta)(1-A)}{(1+\theta)(p_B+\delta)+\theta-(1+\theta)\delta-i(1-\tau\phi)}$$

$$X(\lambda) = (1+\theta)(p_B+\delta)+\theta-(1+\theta)\delta$$
$$D(\lambda) = (1+\theta)(p_B+\delta)+\theta-(1+\theta)\delta-i(1-\tau\phi)$$

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