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Internal debt and welfare

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Abstract

This paper analyzes how multinational firms' internal debt financing affects high-tax countries. It uses a dynamic small open economy model and takes into account that internal debt impacts both the multinational firms' investment decisions and the government's tax policy. The government has incentives to redistribute income from firm owners to workers. If the government's redistributive motive is not too strong, internal debt reduces welfare in the short term by decreasing tax revenues. However, debt financing stimulates capital accumulation and exerts a positive long-term welfare impact.

1 | INTRODUCTION

Multinational enterprises (MNEs) shift a large proportion of their profits to tax havens. In 2015 more than \$600 billion, or 36% of multinationals' worldwide profits, were shifted (Tørsløv et al., 2018). Internal debt serves as one of the main channels of international tax planning and accounts for 25%–30% of the shifted profits (Beer et al., 2020; Heckemeyer & Overesch, 2017). Hence, in its initiative on base erosion and profit shifting, the OECD calls for, inter alia, measures to address base erosion through internal debt (OECD, 2013, 2015). Moreover, the number of countries applying thin-capitalization rules (TCRs; i.e., rules that limit interest deductibility) increases over time (Merlo & Wamser, 2015).¹

Here, I analyze the welfare effects of internal debt in the short and long run. I show that these effects are not necessarily negative. Furthermore, they may be nonmonotone, with negative short- and positive long-term welfare implications.

¹From 1996 to 2012, the number of countries applying TCRs increases from 24 to 61 (Merlo & Wamser, 2015). Also, 21 countries made the rules stricter, and only six countries relaxed them.

This paper builds a dynamic small open economy model. There is one high-tax (nonhaven or host) country that hosts a national firm and a subsidiary of a foreign-owned MNE. Workers supply labor that is perfectly mobile between the national and multinational sectors. The MNE invests mobile capital in the host country, and capital adjustment is subject to installation costs. Because of installation, it takes time for new investment to augment the firm's capital stock. The MNE's headquarters can channel equity financing to its subsidiary as internal debt through a financial center located in a tax haven. The host country government uses a TCR to restrict such behavior. Moreover, it chooses a time-invariant corporate tax rate and redistributes income from firm owners to workers.

First, I study the short- and long-term welfare implications of allowing for some internal debt use. The short term differs from the long term because installation of new investment prohibits the MNE from adjusting its capital stock immediately. The results are, in general, ambiguous. However, if the government's redistributive motive is sufficiently weak, welfare declines unambiguously in the short term and increases in the long term. The intuition is the following. A TCR relaxation stimulates profit shifting and lowers the MNE's cost of capital for a given statutory tax rate. The increase in profit shifting reduces the tax revenues directly, while the cost of capital effect stimulates investment and may increase the optimal tax rate. In the short term, the capital stock adjusts slowly because new capital installation takes time. Hence, welfare declines if the change in the optimal tax rate cannot compensate for the loss of tax revenues (which is the case for a sufficiently weak redistributive motive). In the long term, capital accumulates, which increases welfare to a level that is ultimately higher than its initial level.

Second, I analyze the optimal internal debt restriction as well as the timing of its benefits and costs. Similarly to the case of a TCR relaxation, the optimal TCR balances short-term marginal costs and long-term marginal benefits.

Furthermore, a numerical simulation of the model looks at the welfare effects of increasing the TCR from zero to its optimal level. It shows that the negative short-term effects may be long-lived. Moreover, when the government has strong redistributive motives, the numerical analysis finds positive short- and negative long-term welfare changes. This case emerges when the optimal tax rate increases strongly following the reform and the long-term capital stock declines.

Nonmonotone welfare effects emerge due to the dynamic nature of the MNEs' responses to TCR reforms, which is supported by the empirical literature. Weichenrieder and Windischbauer (2008) and Buslei and Simmler (2012) analyze the short-term effects of two reforms in Germany from 2001 and 2008, respectively. Weichenrieder and Windischbauer (2008) look at the impact on the capital stock of subsidiaries of foreign-owned MNEs in Germany 2 years after the 2001 reform, while Buslei and Simmler (2012) analyze investment of the same type of firms 1 year after the 2008 reform. Both papers do not identify any significant effects on the capital stock and investment, respectively. Moreover, Harju et al. (2017) measure the real effects of a 2014 TCR reform in Finland through its impact on output in the 2 years following the reform. They do not find any significant effects.

However, in accordance with my results, the empirical literature finds significant long-term real effects of debt financing. Buettner et al. (2008) analyze the long-term impact of TCR on investment using a panel data set of German multinationals' affiliates in 36 countries. They find statistically and economically significant adverse effects of both the implementation and tightening of TCRs. Moreover, Buettner et al. (2018) find significant negative long-term impacts of TCRs on the MNEs' capital stock and the capital stock's tax rate sensitivity in high-tax

countries. In addition, De Mooij and Liu (2018) use panel data of MNEs operating in 34 countries over 2006–2014. They find that a TCR introduction doubles the tax rate sensitivity of investment. Furthermore, Blouin et al. (2014) show that TCRs imposed on affiliates of US MNEs lower the overall firm valuation as measured by Tobin's q . Because Tobin's q is a good predictor of investment (Erickson & Whited, 2000; Philippon, 2009), the results of Blouin et al. (2014) also suggest a long-term impact of TCR on investment. Furthermore, Suárez Serrato (2019) studies the long-term real effects of elimination of tax haven use by US multinationals and finds negative investment and employment effects. While Suárez Serrato (2019) cannot distinguish between different profit-shifting channels, his results are consistent with this paper's predictions.

Therefore, my results highlight the importance of the timing of policy reforms' empirical evaluation. For example, a long-run analysis of the reforms analyzed by Weichenrieder and Windischbauer (2008), Buslei and Simmler (2012), and Harju et al. (2017) might produce different outcomes.

Furthermore, the paper's results have the following policy implications. Consider, for example, a reform that restricts the TCR in a country. The reform is likely to raise tax revenues in the short term at the cost of adverse long-term investment effects. Hence, policymakers may need to complement such reforms with other measures that stimulate investment. Moreover, the observed growth in the use of TCRs (Merlo & Wamser, 2015) may be attributed to policymakers maximizing short-term objectives. This may happen owing to political economy reasons. Foremny and Riedel (2014) find evidence that local business taxes' growth significantly slows in election years and significantly increases in the year after an election. A possible explanation of the results is that shortly before (after) an election, policymakers care more (less) about reelection and are more (less) likely to put a higher weight on their policy's short-run impact. This paper's results suggest that TCR policies may also involve a conflict between the short and long term. Hence, if political economy considerations affect the choice of corporate taxes, they may also impact the setting of TCRs.

Moreover, this paper contributes to the theoretical literature on the welfare implications of internal debt, which finds conflicting results. The two seminal papers are by Hong and Smart (2010) and Haufler and Runkel (2012) and both studies consider static models. First, Hong and Smart (2010) find that (some) internal debt is unambiguously welfare-improving for a small open high-tax country. I show that the results of the static model of Hong and Smart (2010) hold in the long term but might be reversed in the short term. Second, Haufler and Runkel (2012) find in a two-country model with a fixed capital supply and no redistributive motive by the government that zero internal debt is optimal (from the social planner's perspective).² In my model, the short-term capital stock is fixed due to its adjustment costs. In the absence of a strong redistributive motive, welfare is decreasing in internal debt in the short term. Thus, the Haufler and Runkel (2012) result also holds in the short term of a one-country model with elastic capital supply.

Additionally, the paper examines two extensions of the model. The first extension considers a time-varying statutory tax rate and shows that all results remain qualitatively unchanged. The second extension endogenizes the domestic firm's capital stock, which is shown to be declining in the TCR. The reason is that, by stimulating investment by the MNE, internal debt exerts a

²Haufler and Runkel (2012) also find that local governments choose to allow for debt financing. However, this is a race-to-the-bottom result. Thus, debt financing makes each country worse-off.

positive effect on wages, and hence lowers both labor and capital demand in the domestic sector. While this extension is analytically intractable, numerical analysis shows that the long-term welfare effects of TCR relaxation may be negative (owing to its negative impact on domestic capital).

This paper is related to the literature on the implications of profit shifting for nonhaven countries' welfare. All in all, there is no consensus on whether tax havens are good or bad. On the one hand, eliminating tax havens is beneficial to nonhaven countries if it improves public good provision (Haufler & Runkel, 2012; Slemrod & Wilson, 2009) or if it removes the secrecy of firm ownership (Weichenrieder & Xu, 2019). On the other hand, eliminating tax havens may have an ambiguous impact on nonhavens' welfare if it intensifies the tax competition among the high-tax countries (Johannessen, 2010) or if it is only partial and lowers competition among the remaining havens (Elsayyad & Konrad, 2012). Some profit shifting may benefit high-tax countries if it raises the optimal tax rates of low-tax jurisdictions (J. Becker & Fuest, 2012). Moreover, international tax planning may be good for nonhavens if MNEs' organizational form responds to tax discrimination (Bucovetsky & Haufler, 2008), if governments respond to tax planning by changing their tax enforcement strategies (Chu, 2014), or in the presence of lobbying by the owners of immobile capital (Chu et al., 2015). Peralta et al. (2006) find possible beneficial welfare effects of profit shifting among nonhaven countries when the MNE also chooses the location of its productive subsidiary. Choi et al. (2020) find that some profit shifting may mitigate inefficiencies of MNE production and thus benefit consumers in high-tax countries.³

This paper differs from the remaining literature by developing a dynamic model that differentiates between the short- and long-term effects of profit shifting. It is also the first to derive nonmonotone welfare effects of profit shifting.

Moreover, closely related are Gresik et al. (2015, 2020) who analyze, in a static model, the interrelation of internal debt and transfer pricing. They analyze the case where transfer price manipulation is so aggressive that it eliminates the benefits of Foreign Direct Investment (FDI). In such cases, setting a restrictive TCR is the optimal policy that discourages MNEs from investing in the country.

This paper is also related to the literature on dynamic tax competition. Wildasin (2003) is the first to show that the government of a dynamic small open economy chooses a positive time-invariant tax on capital, while Wildasin (2011) extends the analysis to two mobile factors of production. Moreover, Wildasin (2003) shows that mobile capital taxation may benefit immobile factors of production in the short run even if it is harmful in the long run. Thus, he derives nonmonotone welfare effects of capital taxation. This paper extends the seminal Wildasin (2003) framework to study profit shifting. By doing so, I show that profit shifting may also exert similar nonmonotone effects.⁴

Finally, this paper is related to the recent literature that studies the real effects of profit shifting. Suárez Serrato (2019) finds that eliminating profit shifting to tax havens lowers investment, employment, and wages of affected US multinationals with negative spillover effects to other firms. Alvarez-Martinez et al. (2018) find profit shifting to have positive effects on

³Furthermore, Desai et al. (2006a) find empirical evidence that high-growth firms are more likely to operate in tax havens. Desai et al. (2006b) explain this result theoretically in a model, where tax haven use raises the return on investment.

⁴Additionally, this literature analyzes the interaction between tax competition and economic growth (see, e.g., D. Becker & Rauscher, 2013; Köthenbürger & Lockwood, 2010).

investment and gross domestic product (GDP) in the European Union (EU), the United States, and Japan (these effects are, however, insufficient to compensate for the loss in tax revenues). Buettner et al. (2008, 2018) and De Mooij and Liu (2018) find negative effects of internal debt restrictions on investment by MNEs' subsidiaries, while De Mooij and Liu (2020) find similar effects for restrictions on transfer price manipulation. Klemm and Liu (2019) show that profit shifting may stimulate investment in both high- and low-tax countries. The present paper contributes to this literature by linking the real effects of profit shifting to welfare in the short and long term.

The rest of the paper is structured as follows. Section 2 presents the model. Sections 3 and 4 derive the optimal tax policy and the welfare effects of internal debt, respectively. Section 5 presents the extensions, and Section 6 concludes.

2 | THE MODEL

I consider a dynamic model of a small open high-tax country akin to the static framework of Hong and Smart (2010). There are two types of infinitely lived agents in the economy: workers and a representative entrepreneur. The economy produces a single homogeneous good in two firms (sectors): a domestic firm owned by the entrepreneur and a foreign-owned subsidiary of a multinational firm. Workers supply one unit of labor, which is fully mobile between the national and multinational sectors.

The domestic sector employs labor input L^d and fixed entrepreneurial capital K^d to produce the homogeneous good.⁵ Suppressing the exogenous capital stock, the domestic production technology is given by $G(L^d)$, where $G_L > 0 > G_{LL}$, where the subscript denotes a partial derivative. Thus, labor has positive, but diminishing marginal product. Denote the time-invariant statutory tax rate as τ , the period t labor employed by the national sector as L_t^d and the period t wage rate as w_t .⁶ Then, the after-tax profit of the entrepreneurial firm in period t is

$$\pi_t^D = (1 - \tau)(G(L_t^d) - w_t L_t^d). \quad (1)$$

In each period, the entrepreneur maximizes the after-tax profit (1) over the labor input L_t^d , which results in the labor demand equation

$$G_L(L_t^d) = w_t. \quad (2)$$

The MNE's subsidiary is modeled similarly to Turnovsky and Bianconi (1992) and Wildasin (2003). It uses the constant returns to scale technology $F(K, L^m)$, where K is the capital stock, L^m the labor input, and $F(\cdot)$ has positive but diminishing marginal products. The firm has an initial capital stock $K(0) = K_0$. The initial capital stock is fully equity financed by the parent, either through new equity issues or retained earnings.

⁵Table 1 summarizes the definitions of all variables and parameters in the model.

⁶I relax the assumption of a time-invariant tax in Section 5.

TABLE 1 List of variables and parameters

Variable/parameter	Name
$L^m (L^d)$	Labor input in multinational (domestic) firm
$K (K^d)$	Capital stock of multinational (domestic) firm
$F(K, L^m)$	MNE production function
$G(K^d, L^d)$	Domestic production function
w_t	Wage rate
r	Interest rate
τ	Statutory tax rate
π_t^D	Period t after-tax profit of domestic firm
$\bar{\pi}_t^M$	MNE's net profit in period t
π_t^M	MNE's net cash-flow in period t
V_t	MNE's equity value
E_t	MNE's quantity of equity shares
q_t	MNE's share price
D_t	Dividend payment
RE_t	Retained earnings
B_t	Internal debt level
b	Thin-capitalization rule
$C^B(rb)$	Deadweight costs of internal debt
$I_t (I_t^d)$	MNE's (domestic firm's) investment
$C(I_t) (C^d(I_t^d))$	MNE's (domestic firm's) capital adjustment cost functions
μ_1	Adjustment speed
$X_t^W (X_t^E)$	Consumption of workers (entrepreneur)
T_t	Tax revenues
Ω_t	Period t welfare
β	Weight of entrepreneur's consumption in welfare
$a_i, i = F, G$	Share of capital in the production function $i = F, G$
χ	Degree of substitutability between capital and labor in $F(\cdot)$
ϕ	Degree of substitutability between capital and labor in $G(\cdot)$
c	Marginal cost parameter in $C(I)$
c^B	Marginal cost parameter in $C^B(rb)$
$\psi_{21}, \psi_{22}, B_{1z}, B_{2z}, z = b, \tau$	Constants determining capital transition path in Section 5.2
$\zeta_i, i = 1, 2$	Adjustment speed parameters in Section 5.2
ϵ	Returns to scale of $F(K, L^m)$ in Section 5.2
ν	Returns to scale of $G(K^d, L^d)$ in Section 5.2

Abbreviation: MNE, multinational enterprise.

The MNE operates a financial center in a tax haven country with a zero corporate tax rate. It can lower the tax liability of its productive subsidiary by channeling a part of the equity financing through the financial center, which in turn provides internal debt, B_t , to the subsidiary at an exogenous world interest rate r . The government constrains internal debt not to exceed an exogenous proportion $b \in [0, 1]$ of the capital stock, that is, $B_t \leq bK_t$.⁷ Following Hong and Smart (2010), Mardan (2017), and Gresik et al. (2017), the MNE incurs costs for using internal financing. Specifically, internal debt creates deadweight costs similarly to external debt (Gresik et al., 2017; Hong & Smart, 2010). These costs may arise because the MNE needs to hire lawyers to structure internal debt in accordance with tax law (Gresik et al., 2017). As in Hong and Smart (2010), the deadweight costs are specified as $C^B(rB/K)K$, where $C^{B'} > 0$, $C^{B''} > 0$ for $B > 0$ and $C^B(0) = C^{B'}(0) = 0$.⁸ These costs are, without loss of generality, not tax-deductible.

The productive subsidiary's interest costs in period t amount to rB_t . These interest costs also equal the net profit generated by the financial center. Define the net profit of the MNE's subsidiary in period t as its gross profit, $F(K_t, L_t^m) - w_t L_t^m$, minus the interest costs, deadweight costs, and tax payments. Then, the sum of the subsidiary's and financial center's net profits in period t is equal to

$$\bar{\pi}_t^M = F(K_t, L_t^m) - w_t L_t^m - rB_t - C^B(rB_t/K_t)K_t - \tau [F(K_t, L_t^m) - w_t L_t^m - rB_t] + rB_t. \quad (3)$$

The profit $\bar{\pi}_t^M$ can either be used to pay dividends D_t or held as retained earnings RE_t to finance new investment.

The MNE augments the capital stock in period t , K_t , at the rate I_t such that the amount of investment is $I_t K_t$.⁹ Assuming, without loss of generality, that capital does not depreciate, the capital stock evolves according to¹⁰

$$\dot{K}_t = I_t K_t. \quad (4)$$

Moreover, the firm incurs convex capital adjustment costs $C(I_t)K_t$, where $\text{sgn}\{C'\} = \text{sgn}\{I\}$, $C'' > 0$, and $C(0) = C'(0) = 0$. Convex adjustment (or installation) costs were initially formalized by Hayashi (1982), and represent the internal costs caused by disruption within the firm due to (dis)investment (House & Shapiro, 2008). Furthermore, adjustment costs are required to explain the firm-level data on investment dynamics (Bloom, 2009; Cooper &

⁷There are two types of TCRs: safe harbor rules and earnings stripping rules. A safe harbor rule limits the debt-to-capital ratio, while an earnings stripping rule allows the deductibility of interest expenses up to a certain proportion of the company's EBITDA. The restriction b on internal debt represents a safe harbor rule, following the modeling choice of Hong and Smart (2010), Haufler and Runkel (2012), Haufler et al. (2018), and Gresik et al. (2020).

⁸An alternative cost function, consistent with the use of a safe harbor rule, is $C^B(B/K)K$. Because the interest rate is exogenous in this model, the two functions lead to the same results. In a model with an endogenous interest rate, the choice of a cost function may affect the results.

⁹The assumption of two different types of capital: an exogenous stock, K^d , employed in the domestic sector, and an endogenous stock, K , employed in the multinational sector, follows Hong and Smart (2010) and Haufler and Runkel (2012).

¹⁰A dot indicates a time derivative.

Haltiwanger, 2006).¹¹ Therefore, to install $I_t K_t$ units of capital, the firm needs additional $C(I_t)K_t$ units of output (Turnovsky, 1997, p. 57).

The (costly) installation is crucial to the model because it creates a delay from new investment to capital stock adjustment. While the firm can respond immediately to any shock in period t with a change in investment I_t , this new investment must be installed and can only augment the capital stock in period $t + dt$.

Thus, the total costs of investment in period t are $(I_t + C(I_t))K_t$. The firm finances these costs through retained earnings RE_t and new equity issues $q_t \dot{E}_t$, where q_t is the price of equity and E_t denotes the stock of existing equity in period t .

Subtraction of the capital adjustment costs from the net profit $\bar{\pi}_t^M$ gives the net cash-flow generated by the MNE's subsidiary in period t , π_t^M :

$$\begin{aligned} \pi_t^M = & F(K_t, L_t^m) - w_t L_t^m - (I_t + C(I_t))K_t - C^B(rB_t/K_t)K_t \\ & - \tau [F(K_t, L_t^m) - w_t L_t^m - rB_t]. \end{aligned} \quad (5)$$

Denote the value of equity in period t as $V_t = q_t E_t$. The objective of the firm is to choose the optimal paths of I_t , L_t^m , and B_t to maximize V_0 subject to the TCR constraint $B_t \leq bK_t$. The value of equity V_0 is given by (see Supporting Information Appendix A for a derivation)

$$V_0 = \int_0^\infty \pi_t^M e^{-rt} dt. \quad (6)$$

Thus, the value of the subsidiary in period 0 is the present value of its future net cash-flow, discounted at the interest rate r .¹² Equations (5) and (6) are generalized versions of the equations for net cash-flow and firm value in the model of Wildasin (2003) in the presence of internal debt.

Denote the MNE's optimal internal debt level as \hat{B}_t and the associated debt-to-capital ratio as \hat{b}_t . In the absence of a TCR, the firm's choice would be given by $C^{B'}(r\hat{b}) = \tau$; that is, where the marginal costs equal the marginal tax benefits. The optimal value \hat{b} is time-invariant because of the time-invariant tax rate. Hence, any TCR above \hat{b} would not be binding. However, Proposition 3 later shows that the government's optimal choice of b lies strictly below \hat{b} and is, thus, binding. Therefore, in the remaining analysis, we only focus on the case of a binding TCR: $b_t = b < \hat{b}$.

Supporting Information Appendix B derives the MNE's optimal paths of I_t and L_t^m , which satisfy the following equations:

$$\dot{I}_t = \frac{1}{C''} \left[r(1 - b\tau) + C^B(rb) + C(I_t) + C'(I_t)(r - I_t) - F_K(K_t, L_t^m)(1 - \tau) \right], \quad (7)$$

¹¹Additionally, the convex costs are standard in models of small open economies facing perfectly elastic capital supply and are necessary for the existence of nondegenerate dynamics (Turnovsky, 1997).

¹²One difference between the static model of, for example, Hong and Smart (2010), and the dynamic model is in the formal representation of the cost of capital. In the static model, firms maximize the after-tax profit, where the cost of capital enters negatively as $-rK$. In the dynamic model, we differentiate between investment and capital. The firm maximizes the discounted future cash-flows (Equation 6), which depend negatively on the investment costs $(I_t + C(I_t))K_t$, while the cost of capital (required return on equity) is captured by the discount factor r .

$$w_t = F_L(K_t, L_t^m). \quad (8)$$

Equation (8) equates the marginal product of labor to its marginal cost, while (7) determines the optimal change in investment over time, \dot{I} . The right-hand side of (7) gives the difference between the costs of new investment and its marginal product. Note that in steady-state capital is constant, $\dot{K} = 0$, and, according to (4), $I = 0$. Hence, if a shock increases the marginal costs of investment, the right-hand side of (7) becomes positive. In this situation, the firm disinvests ($I_t < 0$) and to reach steady state, investment must increase to zero, that is, $\dot{I}_t > 0$.

Finally, the labor market must clear in each period t . Thus, we require

$$L_t^d + L_t^m = 1. \quad (9)$$

The model is in steady state when $\dot{I} = \dot{K} = 0$. Denote steady-state variables with a tilde. The steady state is characterized by

$$F_K(\tilde{K}, \tilde{L}^m) = \frac{r(1 - b\tau) + C^B(rb)}{1 - \tau}, \quad (10a)$$

$$F_L(\tilde{K}, \tilde{L}^m) = G_L(\tilde{L}^d) = \tilde{w}, \quad (10b)$$

$$\tilde{L}^m + \tilde{L}^d = 1, \quad (10c)$$

$$\tilde{I} = 0. \quad (10d)$$

The labor demand equations (2) and (8) together with the labor market clearing condition (9) define the labor inputs L_t^d, L_t^m as well as the wage rate w_t as implicit functions of the capital stock, K_t . Denote these functions as $L_t^m \equiv L_t^m(K_t), L_t^d \equiv L_t^d(K_t), w_t \equiv w_t(K_t)$. Totally differentiating (2), (8) and (9) with respect to L_t^m, L_t^d, w_t , and K_t gives

$$\frac{\partial L_t^m}{\partial K_t} = -\frac{F_{LK}}{F_{LL} + G_{LL}} > 0, \quad \frac{\partial L_t^d}{\partial K_t} = -\frac{\partial L_t^m}{\partial K_t}, \quad \frac{\partial w_t}{\partial K_t} = \frac{G_{LL}F_{LK}}{F_{LL} + G_{LL}} > 0. \quad (11)$$

To interpret (11), note that with a constant returns technology, capital and labor are complements in production, that is, $F_{LK} > 0$. Thus, an increase in the capital stock makes labor more productive, which raises the demand for labor in the international sector ($\partial L_t^m / \partial K_t > 0$). The wage rate must increase to balance the labor market ($\partial w_t / \partial K_t > 0$), which lowers the demand for labor in the national sector.

Next, I derive the comparative dynamic effects of a change in the tax rate in period 0 on the capital stock in periods t , where $t \geq 0$. Following Wildasin (2003), Supporting Information Appendix C proves the following result:

Lemma 1. *Suppose the government changes the tax rate τ in period 0 and keeps it constant for all future periods. Then, the change in the capital stock in periods $t \geq 0$ is*

$$\frac{\partial K_t}{\partial \tau} = \frac{\partial \tilde{K}}{\partial \tau} (1 - e^{\mu_1 t}) \leq 0, \tag{12}$$

where μ_1 is the speed of convergence to steady state and is determined by

$$\mu_1 = \frac{r - \sqrt{r^2 - \frac{4(1-\tau)F_{KK}G_{LL}\tilde{K}}{C''(F_{LL} + G_{LL})}}}{2} < 0, \tag{13}$$

while $\partial \tilde{K} / \partial \tau$ is the change in the steady-state capital stock, given by

$$\frac{\partial \tilde{K}}{\partial \tau} = \frac{(F_K - rb)(F_{LL} + G_{LL})}{(1 - \tau)F_{KK}G_{LL}} < 0. \tag{14}$$

Proof. See Supporting Information Appendix C. □

According to Equation (12), in the period of the tax change ($t = 0$), the capital stock remains unchanged. The reason is that the capital stock cannot adjust immediately. When t becomes large, the exponential term in (12) vanishes and the change in the capital stock approached the negative long-term effect, $\partial \tilde{K} / \partial \tau < 0$. The speed of convergence is $|\mu_1|$. If there are no capital adjustment costs, that is, $C(\cdot) = 0$, then $\mu_1 \rightarrow -\infty$ and adjustment is instantaneous. This is the special case of a static model. The higher the change in the marginal adjustment costs, C'' , is, the slower is the rate of adjustment μ_1 . Lastly, the comparative dynamic effects on the labor inputs and the wage rate in periods $t \geq 0$ follow from (11) and (12).

3 | THE GOVERNMENT

Following Hong and Smart (2010), the government's objective is to redistribute income from the entrepreneur to workers. It transfers the tax revenues in a lump-sum way to the workers. The workers do not save and their consumption, X_t^W , equals the total income:

$$X_t^W = w_t + T_t, \tag{15}$$

where $T_t = \tau(G(L_t^d) - w_t L_t^d) + \tau(F(K_t, L_t^m) - w_t L_t^m - rbK_t)$ denotes the tax revenues. The entrepreneur also does not save and its consumption X_t^E is given by

$$X_t^E = \pi_t^D. \tag{16}$$

The government maximizes the welfare function $\Omega_t = X_t^W + \beta X_t^E$ for $\beta \in [0, 1]$, where β strictly less than one represents preferences for redistribution of income to workers.

The government uses the same discount rate r as the multinational firm. This assumption is based on the result from small open economy models with private savings that the time discount rate equals the steady-state interest rate (Turnovsky, 1997). Thus, the government chooses the tax rate to

$$\max_{\tau} \int_0^{\infty} \Omega_t e^{-rt} dt, \quad (17)$$

taking into account the impact of taxation on the capital stock $\partial K_t / \partial \tau$, as well as the functions $L_t^m(K_t)$, $L_t^d(K_t)$, and $w_t(K_t)$. Denote this tax rate as τ^* . It is implicitly determined by¹³

$$\begin{aligned} \frac{\mu_1}{r - \mu_1} \tau^* (F_K - rb) \frac{\partial \tilde{K}}{\partial \tau} = & (1 - \beta) \left[G(\tilde{L}^d) - \tilde{w} \tilde{L}^d - \frac{\mu_1}{r - \mu_1} (1 - \tau^*) \tilde{L}^d \frac{\partial \tilde{w}}{\partial \tau} \right] \\ & + \frac{r}{r - \mu_1} (F_K - rb) \tilde{K}, \end{aligned} \quad (18)$$

where the term $\partial \tilde{w} / \partial \tau < 0$ is defined in Equation (D.5) in Supporting Information Appendix D. The left-hand side of (18) gives the marginal costs of an increase in the tax rate, which lowers the MNE's mobile capital stock. The marginal benefits are on the right-hand side of (18). The term in the first row gives the marginal increase in welfare from additional redistribution from the entrepreneur to workers. It is positive for β strictly less than one (and a not too negative effect of the tax on the wage rate). The term in the second row of (18) arises due to the dynamic adjustment of the capital stock and is initially derived by Wildasin (2003). The slow adjustment of the capital stock following a tax rate increase creates quasirents during the transition period to a new steady state. Since the multinational firm is not owned by the domestic residents, the government has an incentive to tax these rents and distribute them to workers. This term is greater, the slower the adjustment rate is, that is, the closer μ_1 is to zero. In the case of an immediate adjustment, $\mu_1 \rightarrow -\infty$, there are no quasirents, and the second row of (18) vanishes.

Section 4 discusses the long- and short-term effects of a change in profit shifting, as measured by the proportion of internal debt, b . It shows that the dynamic economy may behave in a qualitatively different way from the static one.

4 | EFFECTS OF INTERNAL DEBT

As discussed in Section 1, the existing theoretical literature disagrees on the desirability of internal debt. To address this issue, I first study how, starting from a situation without debt financing, a small permanent relaxation of the TCR affects the optimal tax rate τ^* , the long-term capital stock \tilde{K} , and welfare. Second, I derive the optimal TCR.

Consider first how allowing for some debt financing affects the optimal tax rate and the long-term capital stock. The impact on \tilde{K} is positive if the user cost of capital goes down (and vice versa), where the user cost is determined by the right-hand side of Equation (10a).

Proposition 1. *Suppose that, starting from $b = 0$, the government allows internal debt by a TCR relaxation $db > 0$ in period 0.*

- (a) *If the economy is static ($\mu_1 \rightarrow -\infty$), and the government has a redistributive motive, that is, $\beta \in [0, 1]$, then*

¹³The derivation of (18) is relegated to Supporting Information Appendix D.

$$\frac{d\tau^*}{db} > 0, \quad \frac{d\tilde{K}}{db} < 0, \quad \text{if } \tau^* < \frac{1}{2}. \quad (19)$$

(b) Suppose the economy is dynamic with $\mu_1 \in]-\infty, 0[$. Then, there exists a value $\hat{\beta} \in [0, 1[$ such that for $\beta \in [\hat{\beta}, 1]$, the following results emerge:

$$\frac{d\tau^*}{db} > 0, \quad \frac{d\tilde{K}}{db} > 0. \quad (20)$$

For $\beta < \hat{\beta}$, both the changes in τ^* and \tilde{K} are ambiguous.

Proof. See Supporting Information Appendix E. □

In both cases in Proposition 1, the introduction of internal debt may raise the optimal statutory tax rate. The intuition is that a higher level of b lowers the marginal costs of taxation by reducing the capital stock's tax rate sensitivity. However, the tax rate change is, in general, ambiguous, as b also affects the marginal benefits of taxation.

The capital stock effect depends on whether the higher b lowers the user cost of capital by more than the increase in the statutory tax rate raises it. In the case of a static model (part (a) of Proposition 1), the latter effect dominates for $\tau^* < 1/2$.¹⁴ However, when the convergence to steady state is not immediate, and the government's redistributive motive is sufficiently weak, that is, $\beta \in [\hat{\beta}, 1]$, the net effect on the user cost is negative. Hence, the capital stock is higher in the new equilibrium (part (b) of Proposition 1). The change in \tilde{K} is undetermined for lower values of β .

The intuition behind this ambiguity is the following. In a static model, the only benefit of taxation is its redistributive effect. However, in a dynamic model, the taxation of quasirents is an additional benefit. When β is close to unity (part (b) of Proposition 1), the redistributive motive is weak, and taxation of quasirents is the primary motive for taxation. Hence, the two cases considered above analyze the two extreme situations of (a) only a redistributive motive and (b) a predominant motive to tax quasirents.

How does the capital stock effect reverse its sign, as the convergence changes from immediate to not immediate, that is, as μ_1 changes from $\mu_1 \rightarrow -\infty$ to $\mu_1 > -\infty$? Note that for $\mu_1 \rightarrow -\infty$, the results from part (b) converge to zero as the quasirents disappear. Similarly, as $\beta \rightarrow 1$, the results from part (a) converge to zero, as the redistributive motive vanishes.¹⁵ Suppose we start from the situation $\mu_1 \rightarrow -\infty, \beta \rightarrow 1$, where the effect on the capital stock is zero. Then, adding a redistributive motive would lead to a decrease in the capital stock (part (a)), while adding a motive to tax quasirents would lead to an increase in the capital stock (part (b)). If we add both motives, then the change in the capital stock is positive for $\beta \in [\hat{\beta}, 1]$ and ambiguous otherwise.

¹⁴The condition $\tau^* < 1/2$ is sufficient for the derivation of the results in Proposition 1(a). Note, however, that the results derived later in Propositions 2 and 3 do not depend on $\tau^* < 1/2$.

¹⁵To prove the convergence results, calculate the limits of Equations (E.11) and (E.14) in Supporting Information Appendix E for $\beta \rightarrow 1$, and the limits of (E.16) and (E.19) for $\mu_1 \rightarrow -\infty$. All four equations converge to zero.

Thus, Proposition 1 highlights the role that the convergence rate plays for the relationship between the TCR and the capital stock. Only a small deviation from the case of immediate convergence may affect the capital stock change qualitatively.¹⁶

I turn next to the impact of profit shifting on welfare. In the case of immediate convergence, the model collapses to the static setting of Hong and Smart (2010), and the welfare implications are also identical. Thus, a TCR relaxation, starting from $b = 0$, unambiguously increases welfare if $\beta < 1$ and does not affect welfare if $\beta = 1$ (for a formal statement of this result and a proof, see Lemma 2 in Supporting Information Appendix F). The reason is that this reform allows for more redistribution via a higher statutory tax rate τ^* .

In the dynamic setting, one can distinguish between two effects: the short-term impact (i.e., the change in Ω_0) and the long-term impact (i.e., the change in $\tilde{\Omega}$). While the relationship between internal debt and welfare is, in general, ambiguous, one special case leads to unambiguous results.

Proposition 2. *Suppose the economy is not static, that is, $\mu_1 \in]-\infty, 0[$. Also, starting from $b = 0$, the government allows internal debt by a TCR relaxation $db > 0$ in period 0. Then, there exists $\underline{\beta} \in [0, 1[$ such that for $\beta \in [\underline{\beta}, 1]$, welfare decreases in the short term and increases in the long term:*

$$\left. \frac{d\Omega_0}{db} \right|_{\beta \in [\underline{\beta}, 1]} < 0, \quad (21)$$

$$\left. \frac{d\tilde{\Omega}}{db} \right|_{\beta \in [\underline{\beta}, 1]} > 0. \quad (22)$$

For $\beta < \underline{\beta}$, both the short- and long-term welfare effects are ambiguous.

Proof. See Supporting Information Appendix F. □

Proposition 2 states that, for a sufficiently weak redistributive motive, the short-term welfare effect is unambiguously negative, while the long-term welfare change is positive. Hence, welfare may respond nonmonotonically to an increase in profit shifting. The intuition is the following. In the short term, the capital stock is fixed, and the only welfare effects come from the direct negative impact of b on the tax revenues and the change in the statutory tax rate. Moreover, the tax rate increase does not compensate for the direct loss of tax revenues in period 0 for a sufficiently high β , and welfare declines. During the transition period, the capital stock increases (see Proposition 1), which raises welfare. In the long term, the positive impact of more investment overcompensates the initial negative welfare change. Hence, in the long term, welfare improves.

¹⁶Moreover, Proposition 1 helps explain the reasons for the choice of an infinite horizon framework in this paper. A two-period model, where profit shifting adjusts in period one and capital adjusts in period two, could also derive results similar to Proposition 1(b). First, while such a model would be simpler to analyze, it would not allow the static economy to emerge as a special case. Second, it would not allow us to study the speed of convergence and show that even a very fast but not immediate transition can change the static results qualitatively.

However, the welfare effects of allowing for internal debt are, in general, ambiguous. This is partially a direct consequence of the gradual capital stock transition. Furthermore, the speed of convergence affects the tax rate's response to a change in internal debt, which also impacts the capital stock transition.

Thus, a small deviation from the case of immediate convergence may reveal a qualitatively different short-term welfare effect. The reason is the following. If μ_1 declines, the transition period shortens. As $\mu_1 \rightarrow -\infty$, the short term vanishes as its length converges to zero. Hence, the short term cannot be observed in a static model. Thus, in the static model, the initial condition $dK_0 = 0$ is not observed, while the capital stock reacts fully to policy changes and reaches immediately its steady-state value \tilde{K} . However, for any nonimmediate convergence, the initial condition $dK_0 = 0$ enters the model and allows us to observe the short-term effect (whose sign depends on the value of β).

Moreover, Proposition 2 converges to Hong and Smart's (2010) result as $\mu_1 \rightarrow -\infty$. That is, as the speed of convergence becomes infinite, the positive long-term welfare effect at $\beta = 1$ becomes zero (because the quasirents disappear and the optimal tax rate is $\tau^* = 0$). Furthermore, in this case, $\underline{\beta}$ also approaches zero, such that (22) is positive for any $\beta < 1$. To see this, note that the static welfare effect is a special case of (22), when $\mu_1 \rightarrow -\infty$. Moreover, (21) cannot be observed as $\mu_1 \rightarrow -\infty$ because the initial condition $dK_0 = 0$ does not hold in this (degenerate dynamic) case.

The existing empirical evidence points to a nontrivial short-term adjustment period. Empirical estimates of the speed of convergence lie between $\mu_1 = -0.02$ and $\mu_1 = -0.1$ (Turnovsky, 2002). Furthermore, as discussed in Section 1, the analyses of three different TCR reforms in Germany and Finland do not find real effects for periods of up to 2 years (see Buslei & Simmler, 2012; Harju et al., 2017; Weichenrieder & Windischbauer, 2008). However, Buettner et al. (2008, 2018) and De Mooij and Liu (2018) find significant adverse long-term effects of TCRs on the investment of MNEs' subsidiaries. Moreover, Suárez Serrato (2019) finds that after the access to a tax haven is prohibited to US multinationals, employment of the exposed firms gradually declines for at least 10 years until it settles at a new level (see fig. 8 of Suárez Serrato, 2019).¹⁷ Thus, the short-term effects may last at least 2 years, and full adjustment may take at least a decade.

Moreover, the case of a weak redistributive motive is not unrealistic for the choice of the optimal corporate income tax rate. When $\beta = 1$, welfare Ω equals the jurisdiction's national income: $\Omega = w + T + \pi^D$. Thus, in this situation, the government maximizes national income. This assumption is common in the literature on corporate taxation (see, e.g., Bond & Samuelson, 1989; Janeba, 1995; Wildasin, 2003). Furthermore, policymakers often motivate corporate tax reforms on inter alia efficiency grounds, instead of redistribution motives. For example, the European Commission's proposal for the implementation of a common consolidated corporate tax base (CCCTB) in the EU motivates it partially by stating that "It is equally important to also stimulate growth and economic development in the internal market by facilitating cross-border trade and corporate investment" (European Commission, 2016, p. 12).¹⁸

¹⁷Suárez Serrato (2019) also finds that investment immediately declines following the reform. This result is consistent with the theoretical model presented here, as only the capital stock is fixed in period zero. However, investment changes immediately following an increase in internal debt, that is, $\partial I_0 / \partial b \propto \partial \tilde{K}_0 / \partial b > 0$.

¹⁸However, market regulation is a notable example where governments put a higher weight on consumer surplus relative to firm profits. Regulators may wish to protect consumers on the grounds of, for example, asymmetric information or firm market power (see, e.g., Campbell et al., 2010, for the case of financial products regulation).

In addition, even though both Hong and Smart (2010) and Proposition 2 predict a positive long-term welfare change, the intuition behind these results is different. On the one hand, in Hong and Smart (2010), the capital stock declines. Nevertheless, welfare increases are due to the increase in the statutory tax rate. On the other hand, in Proposition 2, both the tax rate and the capital stock increase.

Next, I derive the optimal TCR. Suppose that the government maximizes the discounted sum of welfare (17) over τ and b .¹⁹

Proposition 3. *The optimal TCR b^* satisfies $0 < b^* < \hat{b}$ for $\beta < 1$ and $b^* = 0$ for $\beta = 1$.*

When the government chooses b^ in time period zero, it faces a strictly positive initial time period $[0, t^*]$ of negative welfare effects*

$$\frac{\partial}{\partial b} \int_0^{t^*} \Omega_t e^{-rt} dt < 0. \quad (23)$$

Proof. See Supporting Information Appendix G. □

Thus, if the government has some redistributive motives, it chooses a positive TCR but allows for less internal debt than the MNE would find optimal. Moreover, the marginal costs of higher internal debt occur in the short term, while its marginal benefits emerge later.

The latter result is independent of β . The welfare effects in Proposition 2 depend on β because of how it impacts $d\tau^*/db$. However, since welfare is maximized over the statutory tax rate, the optimal tax rate's reaction to internal debt, $d\tau^*/db$, does not affect the optimal TCR. Consequently, β does not matter for the sign of the short-term welfare impact of internal financing, when the government chooses b optimally.

How do Propositions 1–3 compare to Hong and Smart (2010)? Hong and Smart (2010) find a positive welfare impact of some internal debt in a static small open economy. Propositions 2 and 3 show that the result of Hong and Smart (2010) continues to hold in the long term of the dynamic model but may be reversed in the short term because of the capital stock's gradual adjustment. Moreover, the negative relationship between the TCR and the capital stock, that Hong and Smart (2010) find, may be reversed in a dynamic model, as shown in Proposition 1(b).

Additionally, in the static model, in the absence of costs of internal debt, the case $\beta = 1$ is characterized by zero optimal tax rate and undefined optimal TCR, $b^* \in [0, 1]$ (see Equation 16 and the proof of Proposition 4 in Hong & Smart, 2010). However, the same case in the dynamic model predicts $\tau^* > 0$ (owing to the taxation of quasirents) and $b^* = 0$. The reason for zero optimal TCR is (i) the government can use only one instrument to tax optimally the quasirents and (ii) there are costs of positive internal debt.²⁰

¹⁹Owing to the Envelope theorem, it does not matter whether the government chooses τ and b simultaneously or sequentially.

²⁰The choice of zero TCR in the absence of redistributive motives, $b^*(\beta = 1) = 0$, does not, however, imply that b^* is necessarily close to zero for β close to but strictly less than one. Specifically, for $\beta < 1$ and $C^{B'} > 0$, we have $0 < b^* < \hat{b}$. However, a reduction in the marginal deadweight costs raises both b^* and \hat{b} , such that, keeping $\beta < 1$, we have

$\lim_{C^{B'} \rightarrow 0} b^* = \lim_{C^{B'} \rightarrow 0} \hat{b} = 1$ (as in Hong & Smart, 2010). On the other hand, keeping $C^{B'} > 0$, an increase in β lowers the benefits of internal debt such that $\lim_{\beta \rightarrow 1} b^* = 0$.

However, Propositions 1 and 2 deliver unambiguous results only for two special cases. To gain intuition regarding the results away from the special cases, Section 4.1 calibrates the model.

4.1 | Simulation

To simulate the model, denote first the domestic technology as $G(K^d, L^d)$, with K^d defined in Section 2 as the exogenous entrepreneurial capital stock. Production is characterized by CES functions: $F(K, L^m) = (a_F K^\chi + (1 - a_F)L^{m\chi})^{\frac{1}{\chi}}$, $G(K^d, L^d) = (a_G K^{d\phi} + (1 - a_G)L^{d\phi})^{\frac{1}{\phi}}$ with $\chi, \phi < 1$ and $a_G, a_F \in]0, 1[$. Oberfield and Raval (2021) estimate an elasticity of substitution for the US manufacturing sector between 0.5 and 0.7. However, using international data Karabarounis and Neiman (2014) find an elasticity of substitution of 1.25. I set $\chi = \phi = -0.2$, which produces an elasticity of substitution equal to 0.83 (the elasticity is defined as $1/(1 - x)$ for $x = \chi, \phi$). Moreover, the share of capital is one-third: $a_F = a_G = 0.33$. The world interest rate is $r = 0.05$ and the weight of entrepreneurs in the welfare function may take three different values: $\beta = 0.9, 0.95, 0.975$. The adjustment cost function as well as the cost of debt are quadratic: $C(I) = 0.5cI^2, c > 0$; $C^B(rb) = 0.5c^B(rb)^2, c^B > 0$.

It remains to choose three exogenous parameters: the cost parameters c, c^B , and the capital stock K^d . They are fixed such that the model matches empirical observations on the tax rate τ , internal debt b , and the speed of convergence μ_1 . First, Buettner et al. (2016) estimate the average τ and b in 36 countries over the period 1996–2004 and get $\tau = 0.34, b = 0.279$ (see Table 2 in Buettner et al., 2016). Second, empirical studies of the speed of convergence find estimates as low as 2%, while standard calibrations of economic models yield values between 6% and 20% (Ortigueira & Santos, 1997). Moreover, there is evidence that the 2% empirical estimates are downward biased (Turnovsky, 2002). In the benchmark case, I target a speed of convergence of 6%, that is, $\mu_1 = -0.06$ and vary this estimate in the sensitivity analysis. Thus, c, c^B , and K^d are set such that the model predicts $\mu_1 = -0.06$ and optimal policies $\tau^* = 0.34, b^* = 0.279$. The resulting parameter values are reported in Panel A of Table 2. Moreover, Panel B of Table 2 reports the values of the endogenous variables. Labor is approximately equally divided between the two sectors and the two capital stocks are also at similar levels.

Because the model has been calibrated to yield the same optimal tax rate and TCR for different β values, I can analyze identical reforms in each case. Suppose the economy initially prohibits internal debt and sets $b = 0$. In this case, the optimal tax rate, $\tau^*(b = 0)$, is reported in Panel A of Table 3 and is approximately 27% irrespective of the value of β . Let there be a reform that sets b at the optimal level, $b^* = 0.279$. Panel B in Table 3 summarizes the impact of this reform on the tax rate, capital stock, and welfare in each of the three cases. The statutory tax rate increases by about 6–7 percentage points, and this effect is slightly decreasing in β . However, one should keep in mind that together with β , we vary c, c^B , and K^d , such that in each case, the model predicts the same optimal policy. Thus, the numerical results in Table 3 cannot be interpreted as the effect of β on optimal policy, *ceteris paribus*. Moreover, because the tax rate increases by less at higher β values, the change in the capital stock increases with β . In fact, at $\beta = 0.9$, the capital stock declines and at $\beta = 0.95, 0.975$, it increases. Thus, $\hat{\beta}$, which is the threshold β value above which Proposition 1(b) holds, is above 0.9 in the first case, and below 0.95 and 0.975 in the second and third cases, respectively.

TABLE 2 Benchmark simulation

	Low β	Middle β	High β
A. Parameter values			
β	0.9	0.95	0.975
χ, ϕ^a		-0.2	
a_F, a_G^a		0.33	
r^a		0.05	
c^b	2.89	3.16	3.27
c^{Bb}	3.04	1.37	0.65
K^{db}	3.35	3.08	2.96
B. Endogenous variables at steady state			
\tilde{K}	2.95	3.24	3.37
\tilde{w}	1.27	1.28	1.28
\tilde{L}^{mc}	0.47	0.51	0.53
τ^{*a}		0.34	
b^{*a}		0.279	
μ_1^a		-0.06	

^aParameter/endogenous variable constant across different β values.

^bParameters chosen such that $\tau^* = 0.34$, $b^* = 0.279$, $\mu_1 = -0.06$.

^c \tilde{L}^d is given by $1 - \tilde{L}^m$.

TABLE 3 Effects of a reform from $b = 0$ to $b = b^* = 0.279$

	Low β	Middle β	High β
A. Optimal tax when $b = 0$			
$\tau^*(b = 0)$	0.269	0.273	0.275
B. Steady-state effects of reform			
$\Delta\tau^*$	0.071	0.066	0.064
$\%\Delta\tilde{K}$	-2.26	0.12	1.04
$\%\Delta\tilde{\Omega}$	-0.043	0.023	0.05

Moreover, long-term welfare declines when $\beta = 0.9$. While this possibility is not included in Proposition 2, it is also not excluded (the proposition only gives a special case). Thus, the static results can be overturned even in the long run of the dynamic model. At higher β values, long-term welfare increases.

Furthermore, Figure 1 plots the evolution of welfare relative to steady-state welfare for $b = 0$ over time (with some abuse of notation, the steady-state welfare before the reform is labeled Ω_0 in Figure 1). The case $\beta = 0.95$ (Figure 1b) shows monotone positive welfare effects (that would be expected if the static model results apply in the dynamic model for all t), while

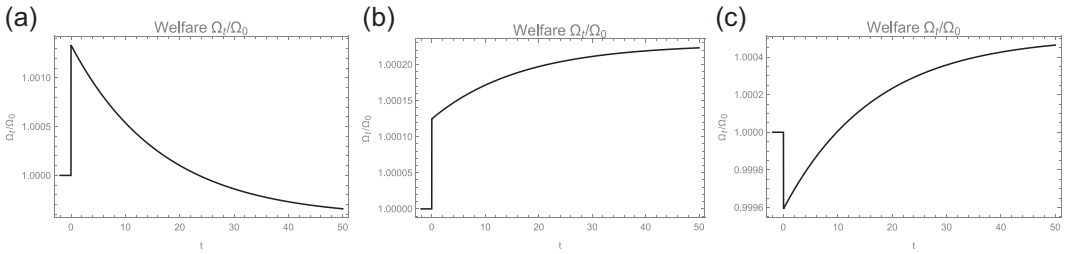


FIGURE 1 Welfare effects for a change from $b = 0$ to $b = b^* = 0.279$ at time $t = 0$ for $\beta = 0.9$ (a), $\beta = 0.95$ (b), and $\beta = 0.975$ (c)

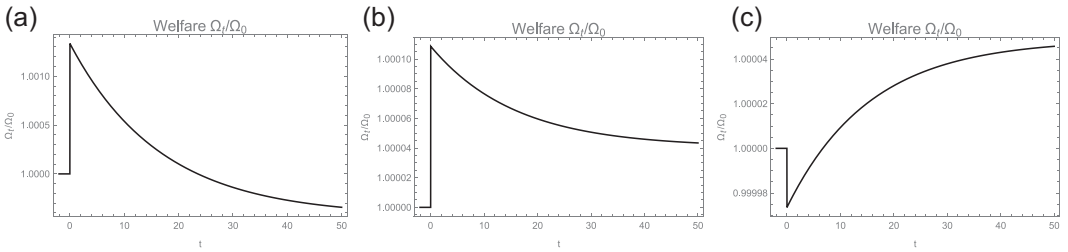


FIGURE 2 Welfare effects for a change from $b = 0$ to $b = b^*$ at time $t = 0$ for $\beta = 0.9$ (a), $\beta = 0.95$ (b), and $\beta = 0.975$ (c), ceteris paribus

$\beta = 0.975$ is consistent with Proposition 2 (negative short- and positive long-term effects). Thus, in the last case, β is below 0.975. Moreover, the negative short-term impact in Figure 1c is long-lived and lasts around 10 years. However, for $\beta = 0.9$, the short-term effect is positive, and the long-term effect is negative (Figure 1a). Thus, at lower β values, the static model results may fail to hold in the long term even though they remain in the short term.

Figure 1 illustrates the welfare effects of TCR reforms under different assumptions about redistributive preferences, holding the optimal policy constant. However, it is also important to understand how β affects the welfare implications of TCR reforms, holding all other exogenous parameters constant. These effects are presented in Figure 2. It illustrates the evolution of welfare following a reform of increasing b from zero to b^* for three different β values, holding c , c^B , and K^d at their values from the column Low β in Table 2. Thus, in the case $\beta = 0.9$, the optimal policy is again characterized by $\tau^* = 0.34$, $b^* = 0.279$, and Figure 2a coincides with Figure 1a. In the second case, $\beta = 0.95$ changes the optimal policy to $\tau^* = 0.28$, $b^* = 0.1$. Here, Figure 2b shows that the short- and long-term effects are positive (as in the analogous case in Figure 1). However, the short-term effect now overshoots the long-term effect. Lastly, when $\beta = 0.975$, the optimal policy is $\tau^* = 0.264$, $b^* = 0.05$. Figure 2c reveals negative short- and positive long-term welfare effects that are qualitatively similar to Figure 1c.

Moreover, Figure 3 shows how the results change with the speed of convergence μ_1 , when we keep the redistribution motive at $\beta = 0.95$. Similarly to Figure 1, here we vary the targeted value of μ_1 , while keeping the targeted policy variables unchanged ($\tau^* = 0.34$, $b^* = 0.279$). On the one hand, under slow convergence ($\mu_1 = -0.02$), Figure 3a shows that the short-term effects become more positive and the long-term effects

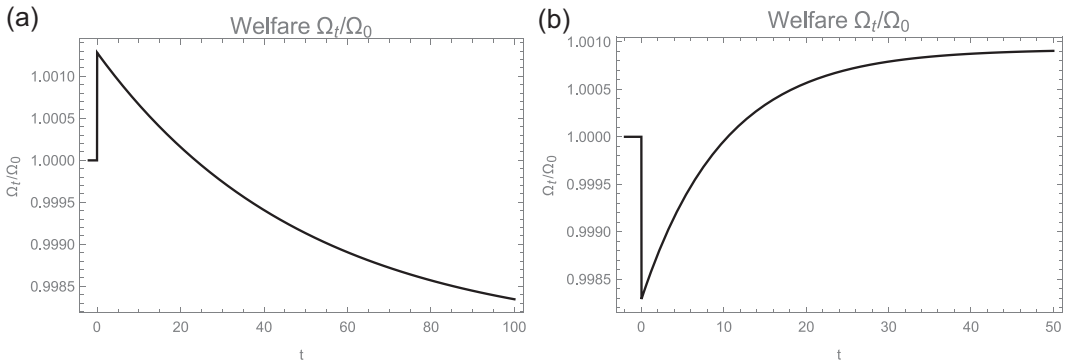


FIGURE 3 Welfare effects for a change from $b = 0$ to $b = b^* = 0.279$ at time $t = 0$ for $\beta = 0.95$ and $\mu_1 = -0.02$ (a) and $\mu_1 = -0.1$ (b)

become negative. This case seems, however, unrealistic because, as the horizontal axis shows, it takes almost 100 years for the economy to reach its new steady state. On the other hand, fast convergence ($\mu_1 = -0.1$) results in negative short- and positive long-term effects. Therefore, calibrating the model to a faster speed of convergence strengthens the case of negative short-term effects. However, one should again keep in mind that, in this simulation, we vary c , c^B , and K^d to keep the optimal policy equal to its observed values and μ_1 at its target value. Hence, Figure 3 does not show the effect of changing the adjustment speed, *ceteris paribus*.

5 | EXTENSIONS

This section presents two extensions of the model. First, I consider a time-varying tax rate and show that all results remain qualitatively unchanged. Second, I consider an endogenous domestic capital stock. This extension becomes analytically intractable and, therefore, I analyze its implications in a numerical analysis.

5.1 | Time-varying tax rate

Section 4 assumes a time-invariant tax rate. In this section, I analyze whether this constraint on the government's policy impacts the results qualitatively. To simplify the analysis, and without loss of generality, assume that the adjustment cost function is quadratic: $C(I_t) = 0.5cI_t^2$, where $c > 0$.

Suppose the tax rate is time-dependent and denote the period t statutory tax as τ_t .²¹ The first-order conditions of the national and multinational firms are again given by (2), (7), and (8), with the only difference that we replace the tax rate τ by τ_t in (7).

²¹By assuming a time-varying tax rate and a constant TCR, this section introduces an asymmetry in the policy parameters. This asymmetry simplifies the analysis and does not affect the results qualitatively. Propositions 1 and 2 analyze the desirability of some internal debt and are independent of whether the TCR is time-varying. While Proposition 3 is quantitatively affected by the assumption of a constant TCR, the bounds on the optimal TCR are not affected by its path.

To solve for the government's optimal tax policy in this case, one needs to determine how investment I_t depends on the statutory tax rate τ_t and the capital stock K_t . Define period t investment as the function $I_t \equiv I_t(K_t, \tau_t)$. In Supporting Information Appendix H, I derive the first and second partial derivatives of the function $I_t(\cdot)$.

The government maximizes the same objective function as in Section 3. Thus, it solves

$$\max_{\tau_t} \int_0^{\infty} \Omega_t e^{-rt} dt \quad \text{s.t.} \quad \dot{K}_t = I_t K_t, \quad (24)$$

taking into account $I_t = I_t(K_t, \tau_t)$, $L_t^m = L_t^m(K_t)$, $L_t^d = L_t^d(K_t)$, and $w_t = w_t(K_t)$. The optimal policy is summarized in the following proposition:

Proposition 4. *The optimal tax rate τ_t is a function of the capital stock K_t , given by*

$$\tau_t = \tilde{\tau} + \alpha(K_0 - \tilde{K})e^{\mu t}, \quad (25)$$

where $\alpha \geq 0$ is defined in Equation (I.17) in Supporting Information Appendix I, while $\tilde{\tau}$ is the optimal tax rate in steady state and is equal to τ^* from Equation (18).

Proof. See Supporting Information Appendix I. □

According to Proposition 4, the optimal steady-state tax is the same as the optimal tax in the model with a constant tax rate. The intuition is that once the economy is in a steady state, the government finds it optimal to levy a constant tax rate, which then coincides with τ^* . However, during the transition period, the optimal tax may either be increasing or decreasing in the capital stock K_t (the exact relationship depends on the properties of the production and the adjustment cost functions).

Therefore, the change in the steady-state tax when some internal debt is allowed is identical to the change of the time-invariant tax rate in the main model. Hence, Proposition 1 can be derived analogously by replacing τ^* with $\tilde{\tau}$. Moreover, the fact that policy responds identically in the long term means that the steady-state welfare impact of an introduction of internal debt is the same as under a constant tax rate (i.e., Equation 22 from Proposition 2 continues to hold). The short-term welfare effect may, however, differ. If $d\tilde{K}/db > 0$, then the tax rate in the period of the shock, τ_0 , increases by less (or decreases more strongly) than $\tilde{\tau}$ if $\alpha > 0$ and vice versa if $\alpha < 0$ (see Equation 25). The reverse is true in the case $d\tilde{K}/db < 0$. In the case of weak redistributive preferences (β sufficiently close to one), the long-term capital stock is increasing in internal debt (according to Proposition 1) and, thus, the initial change in the tax rate is less than the long-term change if $\alpha > 0$ (and vice versa if $\alpha < 0$). Irrespective of whether the initial tax rate change over- or undershoots the long-term change, Supporting Information Appendix J shows that for sufficiently high β , the short-term welfare impact is negative under the additional assumption that the steady state is stable. Lastly, the determinants of the optimal TCR are unaffected by the time path of the tax rate. Thus, Proposition 3 holds. Proposition 5 summarizes these results, while the formal proof is relegated to Supporting Information Appendix J.

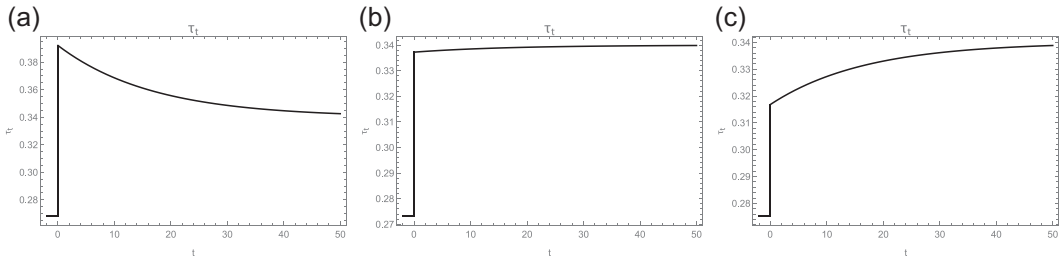


FIGURE 4 Path of optimal tax τ_t for a change from $b = 0$ to $b = b^* = 0.279$ at time $t = 0$ for $\beta = 0.9$ (a), $\beta = 0.95$ (b), and $\beta = 0.975$ (c). The respective values of α are $\alpha = 0.76, 0.69, 0.67$ for $\beta = 0.9, 0.95, 0.975$, respectively

Proposition 5. *In the model with a time-varying tax rate, Proposition 1 holds when one replaces τ^* with $\bar{\tau}$. If the steady state is stable, Proposition 2 remains qualitatively unchanged. Proposition 3 remains qualitatively unchanged.*

Proof. See Supporting Information Appendix J. □

Hence, all previous results are robust to an extension with a time-varying tax rate.

5.1.1 | Simulation

A simulation of the model with a time-varying tax produces the same long-term results as the model with a constant tax. The reason lies in Proposition 4, which states that the long-term optimal tax is equal to the constant optimal tax. However, the transition may differ. Figure 4 plots the path of the optimal tax rate in the benchmark situation from Tables 2 and 3 for each value of β . In all three cases, $\alpha > 0$, that is, the tax rate increases over time if the capital stock increases and vice versa (the exact values of α for each case are reported in the caption to Figure 4). Because for $\beta = 0.9$, the capital stock declines, the tax rate initially overshoots its long-term change, and then declines to its new steady-state value. In the remaining two cases, the capital stock is increasing, and thus the initial tax rate change falls short of the long-term effect. Hence, the tax rate rises over time to reach $\bar{\tau}$.

Figure 5 shows the time path of welfare. While the long-term effects are exactly the same as in Table 3, the short-term impact changes. In the case $\beta = 0.9$, the short-term increase in welfare is much greater than in the situation with a constant tax because of the overshoot in the tax rate increase. Thus, it overshadows the long-term welfare decline graphically. However, when the tax rate initially undershoots the long-term change (in the remaining two cases), short-term welfare deteriorates. Thus, the short-term welfare effects improve (deteriorate) if the tax rate initially overshoots (undershoots).

5.2 | Endogenous domestic capital

Even though it is a standard assumption in the TCR literature that the capital stock in the domestic sector is immobile (see Haufler & Runkel, 2012; Hong & Smart, 2010), it is reasonable

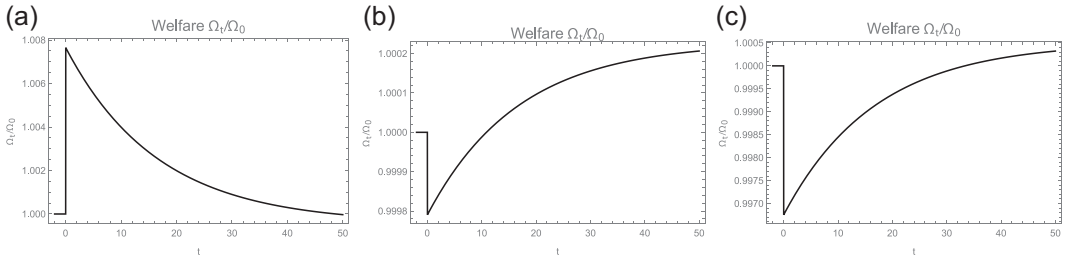


FIGURE 5 Welfare effects for a change from $b = 0$ to $b^* = 0.279$ at time $t = 0$ for $\beta = 0.9$ (a), $\beta = 0.95$ (b), and $\beta = 0.975$ (c)

to consider the effects of tax changes on the domestic capital stock. Hence, this subsection extends the model to study these effects.

Denote the domestic production function as $G(K^d, L^d)$. In period t , the domestic firm invests the amount $I_t^d K_t^d$. The total cost of investment is $(I_t^d + C^d(I_t^d))K_t^d$, where $C^d(\cdot)$ is an installation cost function with the same properties as $C(I_t)$. Hence, the period t net cash-flow of the domestic firm is

$$\pi_t^D = (1 - \tau)(G(K_t^d, L_t^d) - w_t L_t^d) - (I_t^d + C^d(I_t^d))K_t^d, \tag{26}$$

and its capital stock evolves according to

$$\dot{K}_t^d = I_t^d K_t^d. \tag{27}$$

Similarly to the MNE, the domestic firm finances new investment via retained earnings or on the international capital market. Following the same steps as in Supporting Information Appendix A, we derive the domestic firm's value, V_0^d , as the discounted sum of all future cash-flows. The firm value-maximizing labor demand is again determined by (2), while the equation for optimal investment is analogous to (7) (see Supporting Information Appendix K for all derivations). Hence, the steady-state domestic capital stock, \tilde{K}^d , is given by

$$G_K(\tilde{K}^d, \tilde{L}^d) = \frac{r}{1 - \tau}. \tag{28}$$

Together, (10a)–(10c) and (28) determine the steady-state capital stocks, labor inputs, and wage.²² Here, a change in assumptions is necessary. In the main model's simulation, I assume, following Hong and Smart (2010), that both $F(\cdot)$ and $G(\cdot)$ exhibit constant returns to scale. However, in the case of an endogenous K^d , this assumption leads to the same indeterminacy of optimal inputs as in the case of profit maximization of a single representative firm under constant returns to scale. To ensure that the optimal capital and labor inputs are defined, I assume that at least one of the production functions exhibits decreasing returns to scale. Formally, $H_{KK}H_{LL} - H_{KL}^2 \geq 0$, where $H = F, G$ and the inequality is strict for at least one sector. One can interpret decreasing returns to

²²The expression in (10b) represents two equations and thus we have five equations for five endogenous variables.

scale as follows. If in addition to the mobile capital stocks K, K^d , there is a third, truly immobile capital stock used in production, then the economic rents arising due to decreasing returns are the remuneration to this factor of production.

In this extension, Equations (2), (8), and (9) determine the labor inputs and wage rate as functions of both capital stocks, given by $L_t^m(K_t, K_t^d)$, $L_t^d(K_t, K_t^d)$, and $w_t(K_t, K_t^d)$. Moreover, the capital stocks represent two state variables. Thus, the transition following a change in a policy parameter is not characterized by a single adjustment speed. Instead, it is determined by two adjustment parameters. For a change in policy parameter z , where $z = \tau, b$, we have the following equivalent of Lemma 1:

$$\frac{\partial K_t}{\partial z} = \frac{\partial \tilde{K}}{\partial z} + B_{1z}e^{\zeta_1 t} + B_{2z}e^{\zeta_2 t}, \quad (29)$$

$$\frac{\partial K_t^d}{\partial z} = \frac{\partial \tilde{K}^d}{\partial z} + B_{1z}\psi_{21}e^{\zeta_1 t} + B_{2z}\psi_{22}e^{\zeta_2 t}, \quad (30)$$

where $\zeta_1, \zeta_2 < 0$ determine the speed of convergence and $B_{1z}, B_{2z}, \psi_{21}, \psi_{22}$ are constants that are derived in Supporting Information Appendix K. Unfortunately, the model quickly becomes analytically intractable and a derivation of results similar to those from Proposition 1 is in general not possible. Furthermore, while Supporting Information Appendix K derives the optimal tax rate τ^* and TCR b^* (see Supporting Information Equations K.35 and K.36), a detailed analysis of the short- and long-term welfare effects similar to Proposition 2 is also not possible. Therefore, I look at a numerical simulation.

5.2.1 | Simulation

The simulation in this section assumes that the production functions take the form $F(K, L^m) = (a_F K^\chi + (1 - a_F)L^{m\chi})^{\frac{1}{\chi}}$, $G(K^d, L^d) = (a_G K^{d\phi} + (1 - a_G)L^{d\phi})^{\frac{1}{\phi}}$, where a_F, a_G, χ, ϕ are as defined in Section 4, while $\epsilon, \nu \in]0, 1]$ determine the returns to scale. The simulation in Section 4 considers a special case where $\epsilon = \nu = 1$.

In this simulation, I use the same values for a_F, a_G, χ, ϕ as in Table 2. Initially, I simulate the model for $\epsilon = 1$. In this case, ν is chosen such that the variables determining the speed of adjustment, ζ_1, ζ_2 , take plausible values (as a plausible range, I again view values between -0.1 and -0.02). This condition is satisfied for low ν values. Hence, I consider the cases $\nu = 0.6$ and 0.75 . Then, I simulate the model for $\epsilon = 0.95$. In this case, ν is set once at 0.95 (to consider the situation where the production functions are identical) and once at 0.85 .

Additionally, since the returns to scale play a crucial role here, I consider for simplicity only one β value, and set $\beta = 0.95$ (the middle value from Table 2). To further simplify the simulation and its interpretation, set $c^B = 0$, that is, assume there are no costs of internal debt. While these costs are necessary in the main model for an interior solution of b^* , they are no longer necessary in the case of endogenous domestic capital stock. The reason is that an increase in b stimulates investment by the MNE, which raises the wage rate and thus lowers both the labor demand and capital stock of the domestic firm (see Equations K.10–K.13 in Supporting Information Appendix K). Therefore, even in the absence of costs of internal financing, the optimal TCR is below 100%.

TABLE 4 Speed of adjustment and effects of a reform from $b = 0$ to $b = b^* = 0.279$

	$\epsilon = 1$		$\epsilon = 0.95$	
	$\nu = 0.6$	$\nu = 0.75$	$\nu = 0.95$	$\nu = 0.85$
<i>A. Calibrated parameter values^a</i>				
ζ_1	-0.1	-0.098	-0.161	-0.169
ζ_2	-0.024	-0.01	-0.0149	-0.083
<i>B. Optimal tax when $b = 0$</i>				
$\tau^*(b = 0)$	0.283	0.28	0.277	0.29
<i>C. Steady-state effects of reform</i>				
$\Delta\tau^*$	0.057	0.06	0.063	0.05
$\%\Delta\tilde{K}$	2.8	3.43	23.72	8.29
$\%\Delta\tilde{K}^d$	-10.56	-14.12	-30.42	-17.6
$\%\Delta\tilde{\Omega}$	-0.25	-0.49	-3.53	-0.94

^aPanel A reports only the calibrated speeds of adjustment ζ_1, ζ_2 . The respective adjustment cost parameters are $c = 2.44$, $c^d = 21.99$ ($\epsilon = 1, \nu = 0.6$), $c = 2.49$, $c^d = 46.09$ ($\epsilon = 1, \nu = 0.75$), $c = 0.86$, $c^d = 12.43$ ($\epsilon = \nu = 0.95$), $c = 0.99$, $c^d = 1.85$ ($\epsilon = 0.95, \nu = 0.85$).

Moreover, similarly to Section 4.1, the adjustment cost functions are quadratic and given by $C(I) = 0.5cI^2$, $C^d(I^d) = 0.5c^dI^{d2}$. The parameters c and c^d are chosen such that the model predicts optimal tax rate $\tau^* = 0.34$ and TCR $b^* = 0.279$, as in the main model. Table 4 presents the estimated parameters ζ_1, ζ_2 , as well as the long-term effects of a reform that changes the TCR from $b = 0$ to $b^* = 0.279$ in period 0.

As Panel A from Table 4 shows, if the MNE's production is characterized by constant returns to scale ($\epsilon = 1$) and $\nu = 0.6$, then ζ_2 is at the upper bound of the target range. Increasing ν to 0.75 makes ζ_2 even smaller in absolute value. At $\epsilon = \nu = 0.95$, ζ_1 (ζ_2) indicate very fast (slow) convergence. Lowering ν to 0.85 sets the value of ζ_2 in the plausible range without affecting ζ_1 's value.²³

When looking at a reform of raising the TCR from zero to b^* , the effect on the tax rate in all four cases is very similar to the main model. The tax rate rises by 5–6 percentage points. However, there is now a strong positive impact on \tilde{K} and an even stronger negative effect on \tilde{K}^d . The domestic capital stock declines because of the increase in both b and τ . The negative change in the domestic capital stock furthermore leads to negative long-term effects of the reform (in all four scenarios). Thus, introducing an endogenous domestic capital stock may qualitatively change the static model's welfare prediction in the long term.

Furthermore, Figure K.1 in Supporting Information Appendix K shows the evolution of welfare over time. In the two cases where $\epsilon = 1$, welfare initially declines, then improves over the medium term and declines again over the long term. However, in the two cases with $\epsilon = 0.95$, the short-term effects are positive and the long-term effects are negative. Therefore,

²³Further reduction of ϵ makes ζ_1 implausibly negative. For example, at $\epsilon = 0.9$, ζ_1 takes values around -0.5 (not reported in Table 4).

the short-term effects of internal debt in the case of endogenous domestic capital stock depend crucially on the form of the production technologies in each sector.

Moreover, the results in this extension may also crucially depend on other assumptions, such as the zero domestic ownership share of the MNE, and the lack of a savings decision by domestic workers and entrepreneurs. Further extending the model in these directions is however beyond the scope of this paper and left for future research.

6 | CONCLUSIONS

This paper addresses the real effects as well as the welfare implications of profit shifting through internal debt. I develop a dynamic model to take explicitly into account that capital is less mobile in the short run compared with the long run. If the government's redistributive motive in a high-tax country is not too strong, nonmonotone welfare effects emerge, with negative short- and positive long-term effects.

Hence, policy reforms that restrict internal debt may only be beneficial in the short term. Therefore, an important policy implication of this paper is that such reforms should also include measures to stimulate investment. Furthermore, the observed tightening of TCR restrictions in many countries might be explained by policymakers prioritizing short-term gains over long-term adverse effects. Analyzing such political economy considerations is an important avenue for future empirical research.

Furthermore, a numerical simulation shows that the long-term welfare effects may be reversed when (i) the redistributive motive is relatively strong or (ii) the domestic capital stock is endogenous. Moreover, in the numerical analysis, TCR reforms have opposing effects on the domestic and MNE's capital stocks. Future empirical work should quantify these effects, as well as the effects on labor demands in both sectors.

This paper's results also contribute to the theoretical literature on internal debt and welfare. When governments have weak redistributive motives, Hong and Smart's results hold in the long term, but are reversed in the short term. Also, one similarity to Haufler and Runkel (2012) emerges, even though they use a different model. A relaxation of the TCR cannot affect the capital stock both from the social planner's perspective in a model with fixed capital supply (Haufler & Runkel, 2012) and in the short term of a dynamic model with perfectly elastic capital supply. Hence, the welfare effects of internal debt are qualitatively similar in both cases.

Additionally, my results highlight the importance of the timing of empirical evaluation of TCR reforms. A reform that restricts the interest expenses' deductibility may be evaluated as having either no or negative real effects depending on how much time has passed between the reform and the time of analysis. The empirical literature supports this conjecture. While Weichenrieder and Windischbauer (2008), Buslei and Simmler (2012), and Harju et al. (2017) do not find real effects of three different TCR reforms up to 2 years after these reforms took place, Buettner et al. (2008, 2018) and De Mooij and Liu (2018) find such effects over a longer time horizon.

Moreover, the results emerge because debt financing affects the user cost of capital. Similar results should also hold for other profit-shifting mechanisms if they also affect the user cost. Such effects may emerge if, for example, the concealment costs are a function of the capital stock. A dynamic analysis of other profit-shifting channels is left for future research.

One limitation of the model is that it considers a single economy setting. One may argue that in the presence of other high-tax countries, the MNEs' global investment might remain

unaffected by TCRs imposed by a single country. This conjecture is, however, not supported by the existing empirical evidence. Suárez Serrato (2019) finds that eliminating US multinationals' access to one tax haven lowers their global investment despite some shifting of investment away from the US. Thus, the presence of other high-tax countries may mitigate but not overturn the theoretical results. A dynamic analysis of a multi-country setting, probably similar to the static model of Haufler and Runkel (2012), is thus an important agenda for future research.

Furthermore, I do not explicitly model the households' savings and labor supply decisions, and the government's borrowing choice. Additionally, the model assumes perfect capital markets. However, financing frictions exist in many countries and affect both the MNE's financing choices (Desai et al., 2004) and the optimal TCR (Mardan, 2017). Thus, an extension with an imperfect capital market may produce new results. A model with (private and public) borrowing, an imperfect capital market, and endogenous labor supply would likely be analytically intractable, but it would allow for a quantitative evaluation of the welfare effects.

Moreover, this paper views domestic and multinational firms as price-takers. Future work should consider whether MNE's market power affects the welfare implications of profit shifting.

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