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Transfer Pricing and Debt Shifting in Multinationals

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Abstract

There is a growing concern that governments lose substantial corporate tax revenue because of profit shifting through transfer-pricing and thin-capitalization strategies. Existing literature studies profit shifting and transfer pricing separately. In practice, the choice of debt-to-asset ratios in affiliates and the transfer price of debt are interrelated management decisions that are also mutually affected by government regulation. This paper models these strategies as intertwined. We find that the tax sensitivity of the corporate tax base depends on whether the debt shifting and transfer pricing are cost complements or substitutes. A second result is that stricter regulation of debt shifting (transfer pricing) can potentially increase the use of transfer pricing (debt shifting) and thus the amount of profits shifted.

JEL-Code: H250, F230, D210.

Keywords: multinational corporations, profit shifting, debt shifting, concealment costs.

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1 Introduction

Worldwide, there is a growing concern that governments lose substantial corporate tax revenue because of tax planning by multinational companies aimed at shifting profits in ways that erode the taxable base to locations where they are subject to a more favourable tax treatment.[1] In June 2012, in response to such worries, the G20 leaders in Mexico explicitly referred to "the need to prevent base erosion and profit shifting" in their final declaration. From a corporate point of view, however, it is often upheld that business leaders have a responsibility towards their shareholders to legally reduce the taxes their companies pay.

There is a large literature on multinationals and profit shifting that has as its starting point international corporate tax avoidance and evasion.[2] Two of the most commonly used strategies are to shift profits by transfer prices or debt (thin capitalization). Both strategies are regulated by the 'arm's length' standard, which states that inter-unit transactions should be priced the same as the prices chosen by unrelated parties engaged in similar trades under similar circumstances (Eden, 1998; OECD, 2010, art. 9). In many cases, however, it is hard to enforce 'arm's-length-standard' pricing either due to the lack of market parallels, multinationals' use of tax havens, lack of disclosure of either earnings worldwide or of pricing methods.[3] Common to this literature is that transfer pricing is analyzed in separation from debt shifting despite the need to unlock real corporate decisions (see, e.g., Devereux, 2007). In this study, we argue that "real" corporate decisions imply that the choice of debt-to-asset ratios in affiliates and the transfer price of debt are taken simultaneously and, therefore, are interrelated management decisions.[4] In this sense, our paper responds to calls for more research on how regulation and tax law affect managerial decisions (see, e.g., Shackelford and Shevlin, 2001; Hanlon and Heitzman, 2010).[5]

We also make the point that the transfer price and the amount of debt are interrelated

[1] Civil society and non-governmental organizations have been instrumental in fostering this debate. The case of Starbuck's in the UK is one example; see the Reuters Special Report by Bergin (2012).

[2] Early analyses and empirical evidence are provided, e.g., in Copithorne (1971), Horst (1971), Grubert and Mutti (1991), Harris et al. (1993), Klassen et al. (1993), Hines and Rice (1994), Collins and Shackelford (1995), and Jacob (1996).

[3] See, for example, Taylor and Richardson (2013), Dyreng and Lindsey (2009), Hope et al. (2013), Lo and Wong (2011).

[4] A well-documented example of such interrelated tax engineering is found in the Formula One business. Delta Topco Holding, the owner of the Formula One business, hosts several UK-based affiliates under its umbrella. These affiliates carry huge amounts of internal debt, and the interest charged on this debt equals roughly 15% and is payable to a firm part of the group located on the Channel Island Jersey. See Sylt and Reid (2011). The Independent, July 24, 2013, reported that Formula One "*made a net contribution of £945,663 ($1,468,000) in corporation tax in 2011 on revenues of £980m ($1.5bn) – even though the majority of its commercial operations are based in the UK.*"

[5] The literature on debt shifting is surveyed by Mintz and Weichenrieder (2010) whilst Gresik (2001) and Göx and Schiller (2007) provide surveys of the transfer-pricing literature. Shackelford and Shevlin (2001) and Hanlon and Heitzman (2010) review (empiricial) tax research in the accounting literature.

because public regulation that affects one of them may have spillover effects on the other. Thin capitalization rules, for example, may make it relatively "cheaper" for the management to manipulate the interest rate on intercompany loans. There may also be economies of scale and scope related to tax planning that intertwines these decisions. For example, skills in concealing abusive transfer-pricing practices may have positive spillover effects on the firm's ability to disguise its real debt-to-asset ratio.

Our paper also contributes to the literature on tax law and regulation, which includes a large number of studies that explain how management responds to public regulation such as thin capitalization rules (see, e.g., Weichenrieder and Windischbauer, 2008; Büttner et al., 2012; Overesch and Wamser, 2013). We add to this literature by showing how management reacts to public regulation when it has two tax-planning tools that are interrelated.

Finally, our paper provides a theoretical foundation for empirical results related to debt shifting and transfer pricing. The main finding in this literature is that the fiscal consequences of transfer pricing are much more severe for the tax base than those related to debt shifting. In relation to transfer pricing, Pak and Zdanowicz (2001), for example, find that the volume of profit shifting in U.S. multinationals was equal to 18% of total reported corporate profits in 2000.[6] Bartelsman and Beetsma (2003) study OECD data and point out that 65% to 87% of the (potential) additional tax revenue, stemming from a unilateral tax increase, is lost due to profit shifting by transfer pricing. In contrast, studies on debt shifting and its response to changes in taxes show that the semi-elasticity of internal debt lies between 0.69 and 1.3, which indicates small behavioral changes following a tax change.[7] A typical example is Büttner and Wamser (2007, p. 25), who state: "*...our findings suggest that the implied magnitude of tax-revenue losses is rather modest even for wholly-owned firms. To conclude, our findings are indicative for substantial costs of adjusting the capital structure for means of profit-shifting.*" In this paper, we show that when management takes into account all costs related to minimize tax at a global level, including the restructuring of the business (cf. Scholes et al., 2009, ch. 1.2), the effects of tax-rate differentials on debt shifting are modest under reasonable assumptions and transfer pricing is a more attractive proposition.

Our analysis is undertaken in a setting where the central management of a multinational firm decides on capital investments, leverage and the price of internal debt across affiliates in different countries in order to save taxes globally. By adopting a centralized framework, we neglect important issues such as principal-agent problems related to managerial effort in decentralized firms, as well as any trade-off between managerial in-

[6]Similarly, recent evidence for transfer pricing in the U.S. is given in Clausing (2003) and Bernard et al. (2006); for Norway in Langli and Saudagran (2004); for Germany in Weichenrieder (2008). Evidence for transfer pricing in European multinationals is given in Dharmapala and Riedel (2013).

[7]See, e.g., Mintz and Smart (2004), Desai et al. (2004), Büttner and Wamser (2007, 2013), Büttner et al. (2009), and Møen et al. (2011).

centives, tax avoidance, and earnings management (see, e.g., Li and Balachandran, 1996). The focus here, however, is on global tax savings where a centralized view allows us to isolate the effects of tax incentives and public regulation on earnings management.[8]

We find that debt shifting reduces the rental rate of capital and therefore increases investments. In contrast, manipulation of interest rates does not affect the rental rate of capital or investments. In a second step of the analysis, we investigate how management behaves if the corporate tax rate is changed. Key questions are whether a higher corporate tax rate leads management to increase the debt-to-asset ratio and charge a higher interest premium on internal debt. The answers to these questions depend on the properties of concealment costs related to internal debt and transfer pricing (interest rate manipulation). A rise in the corporate tax rate makes it more attractive to both increase the debt-to-asset ratio and the volume of profits shifted if we have concealment cost complementarity. Complementarity here means that a higher debt-to-asset ratio reduces marginal concealment costs of transfer pricing (and vice versa). Concealment cost substitutability exists when marginal concealment costs related to profit shifting rise when debt shifting increases (and vice versa). When we have cost substitutability, we find that management behaves in such a way that the corporate tax base becomes less tax sensitive.

Our findings with respect to government regulation are surprising. If a government introduces thin-capitalization rules (or tightens existing rules), we show that under concealment cost substitutability, management may respond by increasing the interest premium or by increasing leverage. This result is counterintuitive, because it suggests that such rules could have unintended effects (both on tax revenue and on the capital structure). On the other hand, if we have concealment cost complementarity, the response to stricter regulation is to lower both the debt-to-asset ratio and the volume of abusive interest expenses.

The sections of the paper are organized as follows. In section 2, we describe the basic model and introduce the concealment cost functions. We derive the optimal use of debt policy and of interest-rate manipulation, and analyze the implications of tax engineering on real investment of the multinational firm in section 3, while in section 4, we examine the tax sensitivity of debt shifting and of profit shifting. The effectiveness and spill-over effects of regulation to protect tax bases are analyzed in section 5. In section 6, we offer some concluding remarks.

[8]The benefits of decentralization could still be achieved in our setting by the use of two sets of transfer prices to achieve different management goals (e.g., Smith, 1992; Nielsen and Raimondos-Møller, 2012).

2 The Model

We set up a model of a multinational firm (henceforth MNC) that has its headquarters (henceforth HQ) located in any country $p \in \{1, n\}$. The MNC can invest in affiliates in n countries. These affiliates are assumed for simplicity to be price takers and they are wholly owned. Each affiliate i employs K_i units of real capital that is used to produce $x_i = F(K_i)$ units of a homogenous good whose output price is normalized to unity. The production function $F(K_i)$ exhibits positive and decreasing returns to capital (i.e., $F_K > 0$ and $F_{KK} < 0$). We shall further assume that world markets for real and financial capital are integrated and that capital is perfectly mobile. Each country is small and cannot influence interest rates and the market interest rate is exogenously given by $r > 0$.

To finance its investments in an affiliate in country i, the HQ can use equity E_i and debt D_i. Debt can be further broken down into external debt $\left(D_i^E\right)$ and internal debt $\left(D_i^I\right)$, where internal debt is obtained by borrowing from related affiliates. We define K_i as the total (real) capital employed by affiliate i and let $b_i^E = D_i^E/K_i$ be the external debt-to-asset ratio. In a similar fashion, $b_i^I = D_i^I/K_i$ is the internal debt-to-asset ratio, and we define the overall leverage ratio (b_i) of the MNC by $b_i = b_i^E + b_i^I = \left(D_i^E + D_i^I\right)/K_i$. Within the MNC, it must be the case that the sum of market interest payments on internal borrowing and lending is zero across all affiliates, that is,

$$\sum_i r \cdot D_i^I = \sum_i b_i^I \cdot r \cdot K_i = 0. \tag{1}$$

The MNC can shift income to affiliates in other countries by under- or overinvoicing intra-firm transactions. We model this by allowing the firm to deviate from the market interest rate by levying a surcharge $\tilde{r}_i$ on the market interest rate in affiliate i. The total interest costs of internal debt are then $r + \tilde{r}_i$, and the amount of profit shifted away from affiliate i is given by

$$P_i = \tilde{r}_i \cdot b_i^I \cdot K_i. \tag{2}$$

The sum of shifted profits across all affiliates can now be written as

$$\sum_i \tilde{r}_i \cdot b_i^I \cdot K_i = 0. \tag{3}$$

Theories of optimal capital structure assume that there are convex costs per unit of capital associated with the use of external and internal debt.

External debt is seen as useful in order to discipline local managers from lax management and "empire-building" strategies. However, as the leverage ratio goes up, the risk of bankruptcy increases and may cause bankruptcy costs, or induce a debt-overhang situation, in which profitable investment is not undertaken. Too much external debt may also be associated with a higher risk premium due to informational asymmetries. As is usual in the literature, we define costs of external debt by a U-shaped function $C_E(b_i^E)$, where the optimal external leverage in absence of taxation (i.e., the cost-minimizing level of external debt) is denoted by $\bar{b}$.[9]

Internal debt also carries costs. In the literature, these are related to various tax-engineering expenses incurred in order to avoid or relax regulations such as thin-capitalization rules and/or controlled-foreign-company (CFC) rules (see, e.g., Fuest and Hemmelgarn, 2005).[10] We add to the cost structure of internal debt by allowing for the possibility that low profits caused by either profit shifting (P_i) or/and high leverage may arouse suspicion by the tax authorities and lead to a costly audit. Hence, low profits due to transfer pricing, say, makes it more costly to use internal debt. In line with this, we define the cost function for internal debt as $C_I(b_i^I, P_i)$.

The costs and benefits of internal and external debt differ as is clear from the definitions of the cost functions above. Internal debt could be seen as tax-favored equity, since it does neither affect the risk of bankruptcy nor reduce any informational asymmetry.[11] It is therefore not unreasonable to assume that the total cost function for debt is additively separable in external and internal leverage, that is, $C_D(b_i^E, b_i^I, P_i) = C_E(b_i^E) + C_I(b_i^I, P_i)$, if external credit markets are perfect (with the exception for costs related to financial distress and bankruptcy).

In line with the standard trade-off literature, we assume that agency costs of debt are convex in leverage, but proportional in real capital employed. For internal debt, designing strategies to avoid anti-avoidance regulation (particularly, working around thin-capitalization rules), and asking for experts' advice imply higher costs.

In terms of imposing structure on the cost function, we assume that there are no debt-related concealment costs when $b_i^I \leq 0$; $C_I(0, P_i) = 0$, even if the firm engages in abusive transfer pricing. In all other cases, costs of internal debt are affected positively by the total amount of profit shifting so that $\partial C_I/\partial P_i > 0$.[12]

Formally, the properties applied to the cost function of debt can be summarized as:

[9]See Hovakimian et al. (2004) and Aggrawal and Kyaw (2010) for recent overviews on costs and benefits of external debt. To focus on the interplay of internal debt and profit shifting and to keep the model simple, we neglect overall bankruptcy costs on the parent level. The latter would set an incentive to shift external debt internationally; see Huizinga et al. (2008).

[10]See for example Mintz and Smart (2004), Fuest and Hemmelgarn (2005), and Schindler and Schjelderup (2012). Thin-capitalization rules are in place in many countries such as Germany, the U.K, and the U.S., and also apply to foreign subsidiaries. See, e.g., Gouthière (2005) for a description of several EU and non-EU countries' rules. Controlled-foreign-company rules are in place, e.g., in the US and Germany and they deny tax-exemption of passive income in the home country of the MNC, provided that tax avoidance is suspected (see Ruf and Weichenrieder, 2012).

[11]Indeed, Gertner et al. (1994) point out that internal debt does not show the properties of external debt and that it should rather be seen as equity. Stonehill and Stitzel (1969) and Chowdhry and Coval (1998, pp. 87) qualify internal debt as "tax-preferred equity", supporting this view.

[12]The effect on the marginal costs of internal leverage from an increase in income shifted (that is, $\partial^2 C_I/[\partial b_i^I \partial P_i]$) is ambiguous, and for the time being, we do not impose any restrictions on it.

Assumption 1 *External credit markets are assumed to be perfect except for the debt tax shield and financial distress costs. The debt cost function is additively separable,* $C_D(b_i^E, b_i^I, P_i) = C_E(b_i^E) + C_I(b_i^I, P_i)$*, and exhibits the properties*

$$
\begin{aligned}
C_E(b_i^E) > 0 \quad & \textit{with} & C_E'(b_i^E) > 0, \quad C_E''(b_i^E) > 0 \quad & \textit{if} \quad b_i^E > \bar{b}_i^E, \\
& & C_E'(b_i^E) \leq 0, \quad C_E''(b_i^E) > 0 \quad & \textit{if} \quad b_i^E \leq \bar{b}_i^E, \\
C_I(b_i^I, P_i) > 0 \quad & \textit{with} & \frac{\partial C_I(b_i^I, P_i)}{\partial b_i^I} > 0, \quad \frac{\partial^2 C_I(b_i^I, P_i)}{\partial (b_i^I)^2} > 0 \quad & \textit{if} \quad b_i^I > 0, \\
& & \frac{\partial C_I(b_i^I, P_i)}{\partial P_i} > 0, \quad \frac{\partial^2 C_I(b_i^I, P_i)}{\partial P_i^2} > 0 \quad & \textit{if} \quad b_i^I > 0, \\
C_I(b_i^I, P_i) = 0 \quad & \textit{with} & \frac{\partial C_I(b_i^I, P_i)}{\partial b_i^I} = \frac{\partial C_I(b_i^I, P_i)}{\partial P_i} = 0 \; \forall P_i \quad & \textit{if} \quad b_i^I \leq 0.
\end{aligned}
$$

Not only do MNCs face costs related to the use of debt, but shifting profit by transfer prices also entails costs. Inspired by the literature on tax evasion (cf. Allingham and Sandmo, 1972; Yitzhaki, 1974), these costs can be interpreted either as costs due to the use of lawyers and accountants, and/or as expected penalties imposed if illegal interest-rate manipulation is detected and fined by the tax authorities. In the latter case, the cost function would imply that the detection probability as well as the fines increase in the amount of shifted profits.[13] Furthermore, we shall assume that the concealment costs of profit shifting depend on the level of internal debt. Accordingly, we define the concealment cost function related to transfer pricing by $C_P(P_i, b_i^I)$, which is a convex function in the level of income shifted (P_i). The convexity in leverage b_i^I is due to that it is more costly to hide (illegal) profit shifting if the debt-to-asset ratio is very high and taxable profits low due to excessive interest deductions.[14] It follows from this that $\frac{\partial C_P}{\partial b_i^I} > 0$.[15] If $P_i \leq 0$, we assume that no costs occur because enlarging the tax base and increasing tax payments in such an affiliate should not induce local tax authorities to investigate and audit the affiliate more closely. Formally, our assumptions are summarized below by

[13] Chan and Chow (1997), for example, find that Chinese tax authorities are more prone to audit MNCs if they show persistent losses or low profitability relative to the industry average. These authors also point out that the comparable-profit method is the most prominent pricing method in China (cf. table 7) and argue that their findings are in line with earlier results for the US. For a detailed analysis of the comparable-profit method under arm's-length regulation see OECD (2010) and Gresik and Osmundsen (2008).

[14] Affiliates of MNCs with lower profits due to a debt-to-asset ratio significantly higher than their peer group are also more likely to be audited.

[15] As under debt, the cross derivative $\frac{\partial^2 C_P}{\partial P_i \partial b_i^I} \gtrless 0$ is ambiguous, either because interest-rate manipulation and internal debt can reinforce concealment costs, or because of positive spill-over effects by enhanced knowledge in hiding tax engineering.

Assumption 2 *The cost function of profit shifting exhibits*

$$C_P(P_i, b_i^I) > 0 \quad with \qquad \frac{\partial C_P(P_i, b_i^I)}{\partial P_i} > 0, \quad \frac{\partial^2 C_P(P_i, b_i^I)}{\partial P_i^2} > 0 \quad if \quad P_i > 0,$$
$$\frac{\partial C_P(P_i, b_i^I)}{\partial b_i^I} > 0, \quad \frac{\partial^2 C_P(P_i, b_i^I)}{\partial (b_i^I)^2} > 0 \quad if \quad P_i > 0,$$
$$C_P(P_i, b_i^I) = 0 \quad with \qquad \frac{\partial C_P(P_i, b_i^I)}{\partial P_i} = \frac{\partial C_P(P_i, b_i^I)}{\partial b_i^I} = 0 \quad if \quad P_i \leq 0.$$

The HQ maximizes global profits after corporate taxation. In the next section, we investigate how the MNC invests, structures its debt, and shifts income to low-taxed affiliates.

3 Profit Shifting and Debt Shifting

Net global profits of the MNC are given by

$$\Pi = \sum_i \left[\pi_i^e - t_i \cdot \pi_i^t\right], \tag{4}$$

where π_i^e is economic profit in subsidiary i, π_i^t is taxable profit, and t_i is the corporate tax rate in country i. Economic profit is given by revenue minus user costs of capital and profit shifting,

$$\pi_i^e = F(K_i) - [r + C_E(b_i^E) + C_I(b_i^I, P_i)] \cdot K_i - P_i - C_P(P_i, b_i^I), \tag{5}$$

The tax code in most countries do not allow costs of equity to be deducted against tax whilst interest expenses are deductible. As a consequence, taxable profit differs from true economic profit. In defining taxable profit, we assume that costs per unit of capital associated with both external and internal borrowing are tax deductible. Some of these costs may be associated with informational asymmetries between investors and managers of the firm, or illegitimate action from the point of view of the tax authority. One could argue that these costs should not be tax deductible. It is straightforward to show by examination of the equations to follow that even if they were not deductible, it would not affect our results.

Taxable profit income can, after some manipulations, be written as

$$\pi_i^t = F(K_i) - [rb_i^E + (r + \tilde{r}_i)b_i^I + C_E(b_i^E) + C_I(b_i^I, P_i)] \cdot K_i - C_P(P_i, b_i^I), \tag{6}$$

where capital invested in country i is financed either by debt $D_i = D_i^I + D_i^E$ or by equity E_i, so that $K_i = D_i^I + D_i^E + E_i$.

The HQ maximizes the value of the MNC after corporate taxes. Personal taxes do not matter, since MNCs often either are owned by many institutional investors, or shareholders located in different countries.[16] The optimization problem of the firm can be seen as a two-tier process: First, it chooses its optimal debt-to-asset ratio and the optimal interest rate on internal debt for any given value of real investment K_i. Second, the firm decides on how much real capital to use and therefore how much of the final good to produce in each country. Taking real investment K_i as fixed initially, the firm's optimal tax-planning behavior is found by maximizing equation (4). Inserting for equations (5) and (6), collecting terms, and taking into account the constraints on internal lending and on profit shifting, that is, equations (1) and (3), the maximization problem can be written as

$$\begin{aligned}
\max_{b_i^E, b_i^I, \tilde{r}_i} \Pi &= \sum_i \Big\{ (1-t_i)\left[F(K_i) - C_P(P_i, b_i^I)\right] \\
&- K_i \left[r - t_i r(b_i^E + b_i^I) + (1-t_i)\left(C_E(b_i^E) + C_I(b_i^I, P_i)\right) + (1-t_i)\tilde{r}_i b_i^I \right] \Big\} \\
s.t. &\sum_i r \cdot b_i^I \cdot K_i = 0 \quad (\lambda) \qquad s.t. \sum_i \tilde{r}_i \cdot b_i^I \cdot K_i = 0 \quad (\eta),
\end{aligned} \tag{7}$$

where λ and η are the associated Lagrangian parameters for internal debt and transfer pricing, respectively.

Optimal manipulation of interest rates. Maximizing (7) with respect to $\tilde{r}_i$, we obtain

$$\eta - (1-t_i) \leq (1-t_i)\left(\frac{\partial C_P}{\partial P_i} + \frac{\partial C_I}{\partial P_i} K_i\right) \quad \forall\, i. \tag{8}$$

The left hand side is the net marginal benefit of profit shifting. It should be equal to or less than the after-tax marginal concealment cost of interest-rate manipulation (right-hand side). The Lagrangian parameter η gives the shadow value of an additional unit of profit income shifted and can be shown to be equal to $\eta = \max_i(1-t_i)$. We shall for convenience let country 1 be the country with the lowest tax rate so that by definition $\eta \equiv (1-t_1)$. The first-order conditions in (8), then, imply that, for internal debt, each affiliate $i > 1$ pays a (positive) surcharge on the market interest rate in order to shift profits into affiliate 1 located in the lowest-tax country. Structuring transactions in this way maximizes the gain from transfer pricing.

[16] It can be shown that from the viewpoint of a shareholder in a MNC, maximizing profits of the MNC after global corporate taxation and maximizing the net pay-off on equity investment after opportunity costs and personal (income) taxes, yield identical results under mild assumptions. For example, if corporate taxes cannot be deducted against personal income tax and if the personal tax rate on dividends and interest income is the same, it is straightforward to show that maximizing the value of the firm to the owner and maximizing corporate profits coincide. These restrictions are fulfilled for a wide range of real world tax codes: the classical corporate taxation system (e.g., in the U.S.), the German system since 2009 ("Abgeltungssteuer"), where interest income, dividends and capital gains are taxed at 25% and deductions for corporate taxes are not possible, and the Norwegian shareholder tax, introduced in 2006.

Tax efficient financing structure. The first-order condition for external debt (b_i^E) is given by

$$C_E^{'}(b_i^E) = \frac{t_i}{1-t_i} \cdot r > 0 \quad \forall\ i. \tag{9}$$

Equation (9) states that the value of the debt tax shield should be exploited up until the point where the associated costs of using external debt equals the marginal value of the tax shield. The positive value of the debt tax shield implies that the optimal leverage ratio of external debt in the presence of taxation (b_i^{E*}) is higher than the optimal leverage ratio in absence of taxation $\left(\bar{b}_i^E\right)$, that is, $b_i^{E*} > \bar{b}_i^E$.

Deriving and rearranging the first-order condition for internal leverage b_i^I, we obtain

$$(t_i - \lambda) r = (1-t_i) \left(\frac{\partial C_I}{\partial b_i^I} + \frac{\partial C_P}{\partial b_i^I} \frac{1}{K_i} \right), \tag{10}$$

where we have used that either equation (8) holds with equality, or that $\tilde{r}_i = 0$.

The left hand side of equation (10) is the net marginal benefit of debt shifting. It should be equal to the tax-adjusted marginal cost of concealing debt and profit shifting. The bracket on the left hand side of (10) consists of the marginal value of interest deductions, t_i, minus the the shadow cost of lending given by the Lagrangian multiplier λ. It is straightforward to show that $\lambda = \min_i t_i = t_1$, since we have defined country 1 as the lowest-tax country. The implication of this is that, in order to maximize its value after tax, a MNC will minimize tax payments by conducting lending activities from the affiliate located in the country with the lowest rate of tax (i.e., affiliate 1 in our model). Consequently, the value of the debt tax shield related to internal debt is given by $t_i - t_1$.

Optimal Real Investment. After determining the optimal degree of leverage and the interest rate on internal debt, the HQ derives the effective cost of capital (evaluated at a tax-efficient financial structure with optimal b_i^{E*} and b_i^{I*} and for the optimal transfer price $\tilde{r}_i^*$). The effective rental rate of capital can be shown to be equal to

$$\begin{aligned} r_i^{eff} \;&=\; r - t_i b_i^{E*} r + (1-t_i) C_E(b_i^{E*}) - (t_i - t_1)\, b_i^{I*} r + (1-t_i) C_I(b_i^{I*}, P_i^*) \\ &\quad - (t_i - t_1) b_i^{I*} \tilde{r}^* + (1-t_i) C_P(P_i^*, b_i^{I*}) \frac{1}{K_i}. \end{aligned} \tag{11}$$

In what follows, we use (11) to derive the following conditions[17]

$$\frac{\partial r_i^{eff}}{\partial \tilde{r}_i} \;=\; -\,(t_i - t_1)\, b_i^{I*} + (1-t_i) b_i^{I*} \left(\frac{\partial C_I}{\partial P_i} K_i + \frac{\partial C_P}{\partial P_i} \right) = 0, \tag{12}$$

$$\frac{\partial r_i^{eff}}{\partial K_i} \;=\; -\frac{1}{K_i} \left[(1-t_i) C_P(P_i^*, b_i^{I*}) \frac{1}{K_i} - (t_i - t_1)\, b_i^{I*} \tilde{r}_i^* \right]. \tag{13}$$

[17]In deriving these results, we have used equation (8) twice.

Inserting for the optimal values of debt and the rental rate of capital into the maximization problem (7), we can express the MNC's maximization problem with respect to its use of capital by

$$\max_{K_i} \sum_i \left((1-t_i)F(K_i) - r_i^{eff}(K_i) \cdot K_i \right),$$

where, after applying equations (12) and (13), the first order condition for capital can be written as

$$F_K^i = \frac{r}{1-t_i} - \frac{t_i}{1-t_i} r b_i^{E*} + C_E(b_i^{E*}) - \left(\frac{t_i - t_1}{1-t_i} \right) r b_i^{I*} + C_I(b_i^{I*}, P_i^*). \tag{14}$$

Equation (14) shows that since debt is tax deductible the use of external and internal debt to save taxes lowers the user cost of capital and leads to higher investment. In contrast, interest-rate manipulation has no direct effect on the user cost of capital. We summarize this as

Lemma 1 *Thin capitalization reduces effective capital costs and increases real investment. Manipulating the interest rate on internal debt affects the investment decision only indirectly via the interplay with internal debt in the concealment cost functions.*

It follows from Lemma 1 that excessive interest premiums do not affect the real activity of firms as long as the use of internal debt does not affect concealment costs related to transfer pricing (and vice versa). However, as seen from equations (11) and (10), manipulating interest rates affects the user cost of capital as well as the tax sensitivity of internal debt if concealment costs of debt shifting and profit shifting also depend on the level of abusive internal interest expenses and internal debt, respectively. The topic of the next section is to explore what the consequences are of such a relationship.

4 The Tax Sensitivity of Debt and of Profit Shifting

In this section, we examine how transfer pricing and leverage decisions are affected by a change in the corporate tax rate. In order to assess how a change in the corporate tax rate affects the use of internal debt, we totally differentiate the first-order condition (9). This yields

$$\frac{db_i^E}{dt_i} = \frac{r}{(1-t_i)^2 \cdot C_E''(b_i^E)} > 0. \tag{15}$$

Equation (15) shows that an increase in the tax rate of country i will induce the MNC to use more external debt, since the value of the debt tax shield has risen. Note that the higher tax sensitivity of external debt is independent of how much profit is shifted through interest manipulation or the use of internal debt.

To facilitate a discussion on how the transfer price ($\tilde{r}_i$) and the internal debt-to-asset ratio (b_i^I) are affected by a tax increase, we must make assumptions on how the marginal cost of internal leverage is affected by profit shifting, that is, on the sign of $\partial^2 C_I/(\partial b_i^I \partial P_i)$. We assume that the effects of one activity on concealment costs of the other activity are qualitatively symmetric, that is, $\text{sign}\{\partial^2 C_I/(\partial b_i^I \partial P_i)\} = \text{sign}\{\partial^2 C_P/(\partial b_i^I \partial P_i)\}$. The sign of this cross-derivative is ambiguous and depends on how debt shifting and transfer pricing affect total concealment costs.

We define concealment cost substitutability the following way:

Definition 1 *Concealment cost substitutability exists, when the marginal concealment costs related to profit shifting (P_i) rise when debt shifting (b_i^I) increases (and vice versa), that is;* $\frac{\partial^2 C_I}{\partial b_i^I \, \partial P_i}, \frac{\partial^2 C_P}{\partial b_i^I \, \partial P_i} > 0.$

To see why marginal concealment costs may rise due to an increase in either transfer pricing or debt shifting, one can perceive that tax authorities compare profits of MNCs' affiliates to profits of their peer group in order to decide on an audit. If an affiliate is having a high internal debt-to-asset ratio, then, if the firm also uses the transfer price to shift profit this reduces profit further and increases the likelihood of a costly audit. Another example relates to thin-capitalization rules. Such rules are meant to prevent a too high debt-to-asset ratio. If the firm shifts too much profit by manipulating the interest rate, profits will be low and this has a negative effect on book equity. Consequently, profit shifting may lead to that thin-capitalization rules come into force and might even induce tax authorities to audit the firm. In order to avoid an audit, the firm must make more use of accountants and lawyers to reduce the probability of an audit.

In line with the definition above, we define concealment cost complementarity as:

Definition 2 *Concealment cost complementarity exists, when the marginal concealment costs related to profit shifting fall when debt shifting increases (and vice versa), that is;* $\frac{\partial^2 C_I}{\partial b_i^I \, \partial P_i}, \frac{\partial^2 C_P}{\partial b_i^I \, \partial P_i} < 0.$

Definition 2 indicates that the cross derivatives may be negative as well. This could happen if there are pure economies of scale. For example, a MNC has acquired special skills in concealing profit-shifting activities due to the sheer volume of such transactions and can use these skills for debt shifting as well (and vice versa).

In order to examine the management response with respect to excessive interest deductions and to internal leverage following a change in the corporate tax rate t_i, we differentiate the first-order conditions (8) and (10) with respect to t_i.[18] The change in internal debt is given by

[18] For a full derivation see the Appendix

$$\frac{db_i^I}{dt_i} = \frac{(1-t_1)\left[A \cdot P_i - B \cdot b_i^I\right]}{(1-t_i)^2 SOC} \begin{cases} > 0 \, if \, \frac{\partial^2 C_I}{\partial b_i^I \partial P_i} < 0, \\ \\ \gtrless 0 \, if \, \frac{\partial^2 C_I}{\partial b_i^I \partial P_i} > 0, \end{cases} \tag{16}$$

where $A = \partial^2 C_P / \partial P_i^2 + \left(\partial^2 C_I / \partial P_i^2\right) K_i > 0$ is the *direct effect* related to increased profit shifting (P_i). It measures the change in marginal concealment costs of profit shifting following a change in the amount of profit shifted (i.e., the curvature of the concealment cost function related to profit shifting). The term $B = \left(\partial^2 C_I / [\partial b_i^I \partial P_i]\right) K_i + \partial^2 C_P / (\partial b_i^I \partial P_i)$ is the *indirect cost interaction effect.* It shows how transfer pricing affects the cost of shifting debt (and vice versa), i.e., whether the concealment cost function inhibits cost substitutability or complementarity. The second order condition is given by the term $SOC > 0$.

If we have concealment cost complementarity ($\partial^2 C_I / \partial b_i^I \partial P_i < 0$), the squared bracket in the numerator in equation (16) is unambiguously positive. In this case internal debt will rise following a tax increase since the direct effect as well the cost interaction effect go in the same direction.

Under concealment cost substitutability the numerator cannot be signed, since the direct effect goes against the cost interaction (indirect) effect. Internal debt may fall or rise following a tax increase depending on the relative magnitudes of the two terms in the squared bracket.

The change in firm behavior when it comes to the amount of profit shifted is given by $dP_i/dt_i = \left(d\tilde{r}_i/dt_i\right) b_i^I K_i + \left(db_i^I/dt_i\right) \tilde{r}_i K_{i,}$ which can be written out in full as

$$\frac{dP_i}{dt_i} = \frac{(1-t_1)\left[D \cdot b_i^I - B \cdot P_i\right]}{(1-t_i)^2 SOC} \begin{cases} > 0 \, if \, \frac{\partial^2 C_I}{\partial b_i^I \partial P_i} < 0, \\ \\ \gtrless 0 \, if \, \frac{\partial^2 C_I}{\partial b_i^I \partial P_i} > 0, \end{cases} \tag{17}$$

where $D = (\partial^2 C_I / \partial (b_i^I)^2) K_i + \partial^2 C_P / \partial (b_i^I)^2 > 0$ is the direct effect on the cost function of increasing internal debt (i.e., the curvature of debt-shifting-related concealment costs).

We may now state the following results:

Proposition 1 *The tax sensitivity of internal debt and profit shifting (P_i) is affected by the concealment cost function in the following way:*

(a) Concealment cost complementarity ($\frac{\partial^2 C_I}{\partial b_i^I \, \partial P_i} < 0$) increases the tax sensitivity of both debt and profit shifting; that is $db_i^I/dt_i > 0$ and $dP_i/dt_i > 0$.

(b) Concealment cost substitutability ($\frac{\partial^2 C_I}{\partial b_i^I \, \partial P_i} > 0$) reduces the tax sensitivity of both debt and profit shifting and $db_i^I/dt_i \gtrless 0$ and $dP_i/dt_i \gtrless 0$.

All else equal, a rise in the corporate tax rate t_i makes it more attractive to increase the debt-to-asset ratio and the interest rate. The exact response from management, however, depends on the properties of the concealment cost functions and in particular the interaction between the direct cost effect and indirect cost interaction effect.

Proposition 1 states that under concealment cost complementarity the direct and indirect cost effect go in the same direction so that a rise in the corporate tax rate induces the MNC to shift more debt and increase the transfer price. As a result, more profits are shifted and the corporate tax base is more tax sensitive. The reason is that under concealment cost complementarity the indirect cost effect mitigates the increase in marginal concealment costs of debt shifting and transfer pricing.

Under concealment cost substitutability, one profit shifting activity, say, manipulating the interest rate, makes it more costly to shift debt. Hence, the direct effect which indicates that it has become more profitable to shift profit is offset by the indirect cost interaction effect. The end outcome, then, depends on the relative magnitudes of the direct and the indirect effect. As a consequence, a higher corporate tax rate may under certain circumstances induce the MNC to shift less profit and/or reduce the debt-to-asset ratio. What is certain is that the tax sensitivity of the corporate tax base is lower than if the two tax-engineering efforts did not interact.

Proposition 2 *Irrespective of the properties of the concealment cost function, the tax sensitivity of interest-rate manipulation* ($d\tilde{r}_i/dt_i$) *cannot be signed, even if a higher tax rate increases the amount of profit shifted* ($dP_i/dt_i > 0$)*.*

The effect on the optimal interest-rate manipulation $\tilde{r}_i$ is ambiguous for any specification of concealment costs. In general, a higher tax rate leads to more profit shifting (rise in $P_i = \tilde{r}_i \cdot b_i^I \cdot K_i$) and induces the MNC to use more internal leverage b_i^I. Since a higher leverage ratio b_i^I also shifts more profit, the interest rate $\tilde{r}_i$ may have to fall to ensure that the optimal amount of profit is shifted.

Our results above should be contrasted to the findings in the empirical literature where a main insight is that the management of a MNC is more likely to respond to a tax change by manipulating transfer prices than debt. In particular, evidence suggests that internal debt is not very sensitive to changes in the corprate tax rate (see e.g., Büttner and Wamser, 2007; Møen et al., 2011). Based on our results in equations (16) and (17), the findings in the empirical literature could be explained by the availability of multiple profit shifting instruments, where debt is an instrument that is more expensive to manipulate. In other words, transfer pricing and debt shifting are cost substitutes and the profile of the concealment cost curve differs for the two, with a high concealment cost curvature for debt shifting and a low for transfer pricing.[19]

[19] In technical terms, the tax-rate sensitivity for each instrument - confer equations (16) and (17) – is determined by the gradients of the marginal concealment costs (all else equal) not the absolute level of the marginal concealment costs.

Cost substitutability will decrease the tax-rate sensitivities of both instruments, all else equal. If under cost substitutability, we have a large increase in marginal concealment costs related to internal debt whereas costs related to transfer pricing are low, we obtain magnitudes of tax sensitivities in line with the empirical literature. Such differences in costs may be explained, for example, by binding thin-capitalization rules, whereas regulation of transfer prices provides the MNC with a larger degree of discretion.

5 Government Regulation

In this section, we study how political measures to protect the tax base affect management decisions. In particular, we examine how thin-capitalization rules, and rules that place restrictions on the amount of profit shifted affect management decisions.

In order to facilitate the analysis, we rewrite the concealment cost function of internal debt as $C_I = C_I(b_i^I, P_i, \sigma_i)$, where σ_i is a parameter that measures the tightness of thin-capitalization rules in country i. A higher σ_i (i.e., tighter thin-capitalization rules) is taken to imply that it becomes more costly to circumvent such rules. We shall also invoke the reasonable assumption that tighter thin-capitalization rules make it more costly to shift debt and profit, that is, $\partial^2 C_I/(\partial b_i^I \partial \sigma_i) > 0$ and $\partial^2 C_I/(\partial P_i \partial \sigma_i) > 0$, but we shall not allow these effects to go to infinity. The latter implies that MNCs may still find ways to circumvent thin-capitalization rules as this seems to be in line with empirical research on thin capitalization rules (see, e.g., Weichenrieder and Windischbauer, 2008; Büttner et al., 2012).

We denote the concealment costs of profit shifting as $C_P = C_P(b_i^I, P_i, \alpha_i)$, where α_i is a parameter that indicates the strictness of arm's-length pricing regulation in country i. An increase in α_i implies higher concealment costs or higher fines if profit shifting is detected. Similar to the case of thin-capitalization rules, stricter transfer-pricing regulation increases marginal concealment costs of manipulating interest expenses, that is, $\partial^2 C_P/(\partial b_i^I \partial \alpha_i) > 0$, $\partial^2 C_P/(\partial P_i \partial \alpha_i) > 0$.

Differentiating the first-order conditions (8) and (10) and doing comparative statics on tighter thin-capitalization rules (σ_i), we find that[20]

$$\frac{db_i^I}{d\sigma_i} = \frac{b_i^I K_i}{(1-t_i)^2 SOC}\left[\frac{\partial^2 C_I}{\partial P_i \partial \sigma_i}\cdot B - \frac{\partial^2 C_I}{\partial b_i^I \partial \sigma_i}\cdot A\right]\begin{cases} < 0 \, if \, \frac{\partial^2 C_I}{\partial b_i^I \partial P_i} < 0, \\ \gtrless 0 \, if \, \frac{\partial^2 C_I}{\partial b_i^I \partial P_i} > 0, \end{cases} \tag{18}$$

$$\frac{dP_i}{d\sigma_i} = \frac{b_i^I K_i}{SOC}\left[\frac{\partial^2 C_I}{\partial b_i^I \partial \sigma_i}\cdot B - \frac{\partial^2 C_I}{\partial P_i \partial \sigma_i}\cdot D\right]\begin{cases} < 0 \, if \, \frac{\partial^2 C_I}{\partial b_i^I \partial P_i} < 0, \\ \gtrless 0 \, if \, \frac{\partial^2 C_I}{\partial b_i^I \partial P_i} > 0. \end{cases} \tag{19}$$

[20] A full derivation for both α_i and σ_i is given in the Appendix.

Comparative statics on the profit-shifting regulation parameter (α_i) yields

$$\frac{db_i^I}{d\alpha_i} = \frac{b_i^I}{(1-t_i)^2 SOC}\left[\frac{\partial^2 C_P}{\partial P_i \partial \alpha_i}\cdot B - \frac{\partial^2 C_P}{\partial b_i^I \partial \alpha_i}\cdot A\right]\begin{cases} < 0\, if\, \frac{\partial^2 C_I}{\partial b_i^I \partial P_i} < 0, \\ \gtreqless 0\, if\, \frac{\partial^2 C_I}{\partial b_i^I \partial P_i} > 0, \end{cases} \tag{20}$$

$$\frac{dP_i}{d\alpha_i} = \frac{b_i^I}{SOC}\left[\frac{\partial^2 C_P}{\partial b_i^I \partial \alpha_i}\cdot B - \frac{\partial^2 C_P}{\partial P_i \partial \alpha_i}\cdot D\right]\begin{cases} < 0\, if\, \frac{\partial^2 C_I}{\partial b_i^I \partial P_i} < 0, \\ \gtreqless 0\, if\, \frac{\partial^2 C_I}{\partial b_i^I \partial P_i} > 0. \end{cases} \tag{21}$$

Based on equations (18) and (19), we may state:

Proposition 3 *Tighter thin-capitalization regulation decrease both debt shifting and profit shifting under concealment cost complementarity. With concealment cost substitutability, tighter thin-capitalization regulation may foster more debt shifting (thin capitalization) or transfer pricing.*

The mechanisms that lead to these results are similar to those explained in the previous section. For concealment cost complementarity, there is a win-win situation from the point of view of the government. Stricter thin-capitalization rules will increase marginal concealment costs and reduce debt shifting and profit shifting. Reduced debt shifting increases marginal costs of profit shifting further and the indirect cost interaction effects induce an even stronger reduction in both kinds of tax engineering. In contrast, when one activity increases concealment costs related to other tax-engineering efforts (i.e., for concealment cost substitutability), the outcome is in general ambiguous and depends on the specific form of the concealment cost functions. In this case, paradoxical outcomes may result. One example is that rules intended to reduce thin capitalization could relax the costs of transfer pricing ($\frac{\partial^2 C_I}{\partial b_i^I \partial P_i}, \frac{\partial^2 C_P}{\partial b_i^I \partial P_i} > 0$) and thus increase profit shifting. Such an outcome would be particularly inauspicious, because profit shifting appears to be more tax aggressive and does not result in any higher investment (contrary to debt shifting; cf. Lemma 1).

When it comes to regulation that affects the firm's ability to shift profit, we summarize the insights from equations (20) and (21) as follows:

Proposition 4 *Under concealment cost complementarity, stricter regulation to prevent profit shifting decreases both debt shifting and profit shifting. Under concealment cost substitutability, regulation may lead to more debt shifting or profit shifting.*

The unintended effects of regulation under concealment cost substitutability is clearly seen from equation (19), where tougher regulation of profit shifting may actually foster more profit shifting and reduce the costs of working around thin-capitalization rules so that the debt-to-asset ratio rises. We stress, however, that regulation in this case may also result in less leverage and profits shifted, and that in general, the outcome depends on the relative magnitudes of the interplay between concealment costs related to the use of internal leverage and profit shifting.

Propositions (3) and (4) show that it is of crucial importance to have knowledge about functional forms of the concealment function when enacting policy to protect the corporate tax base. If concealment cost functions exhibit substitutability, government action may lead to management responses that go in the opposite direction of what the policy aims at achieving.

6 Conclusions

We have examined how concealment costs related to debt shifting and profit shifting affect management responses to changes in corporate taxes, and how government regulation intended to curb profit shifting affects management decisions about profit shifting. We show that policies intended to protect national tax bases may have unintended effects under concealment cost substitutability. Our findings point to that it is of crucial importance to have more knowledge about costs related to activities that often are labelled tax avoidance or tax evasion in order to understand how management behaves. These costs may differ depending on the type of activity the firm engages in, and they may affect other tax-engineering efforts as well. It can be shown that our study carries over to a more general setting where the transfer price is not related to debt.

A Appendix

The first-order condition of external debt (9) is fully separable from the other decisions. Hence, we can neglect it and focus on the other two conditions (8) and (10). Denote the tightness of anti-profit-shifting regulation in country i by parameter α_i and the tightness of thin-capitalization rules in country i by parameter σ_i. The first-order conditions for internal debt (10) and for interest-rate manipulation pricing (8) can be transformed into

$$\begin{aligned} \frac{(t_i - t_1)r}{1-t_i} - \frac{\partial C_I}{\partial b_i^I} - \frac{\partial C_P}{\partial b_i^I}\frac{1}{K_i} &= 0, \qquad (22) \\ \frac{t_i - t_1}{1-t_i} - \frac{\partial C_P}{\partial P_i} + K_i \frac{\partial C_I}{\partial P_i} &= 0, \qquad (23) \end{aligned}$$

where we made us of $\lambda = t_1$ and $\eta = 1 - t_1$.

Totally differentiating these expressions leads to

$$\begin{aligned} \left[\frac{\partial^2 C_I}{\partial (b_i^I)^2} + \frac{\partial^2 C_I}{\partial b_i^I \partial P_i}\tilde{r}_i K_i + \frac{\partial^2 C_P}{\partial (b_i^I)^2}\frac{1}{K_i} + \frac{\partial^2 C_P}{\partial b_i^I \partial P_i}\tilde{r}_i\right] db_i^I + \left[\frac{\partial^2 C_I}{\partial b_i^I \partial P_i} b_i^I K_i + \frac{\partial^2 C_P}{\partial b_i^I \partial P_i} b_i^I\right] d\tilde{r}_i &= \frac{1-t_1}{(1-t_i)^2} r\, dt_i - \frac{\partial^2 C_P}{\partial b_i^I \partial \alpha_i}\frac{1}{K_i} d\alpha_i - \frac{\partial^2 C_I}{\partial b_i^I \partial \sigma_i} d\sigma_i, \\ \left[\frac{\partial^2 C_P}{\partial P_i^2}\tilde{r}_i K_i + \frac{\partial^2 C_P}{\partial b_i^I \partial P_i} + \frac{\partial^2 C_I}{\partial P_i^2}\tilde{r}_i K_i^2 + \frac{\partial^2 C_I}{\partial b_i^I \partial P_i} K_i\right] db_i^I + \left[\frac{\partial^2 C_P}{\partial P_i^2} b_i^I K_i + \frac{\partial^2 C_I}{\partial P_i^2} b_i^I K_i^2\right] d\tilde{r}_i &= \frac{1-t_1}{(1-t_i)^2} dt_i - \frac{\partial^2 C_P}{\partial P_i \partial \alpha_i} d\alpha_i - \frac{\partial^2 C_I}{\partial P_i \partial \sigma_i} K_i d\sigma_i. \end{aligned}$$

and collecting terms results in

$$\begin{pmatrix} \frac{\partial^2 C_I}{\partial (b_i^I)^2} + \frac{\partial^2 C_I}{\partial b_i^I \partial P_i}\tilde{r}_i K_i + \frac{\partial^2 C_P}{\partial (b_i^I)^2}\frac{1}{K_i} + \frac{\partial^2 C_P}{\partial b_i^I \partial P_i}\tilde{r}_i & \frac{\partial^2 C_I}{\partial b_i^I \partial P_i} b_i^I K_i + \frac{\partial^2 C_P}{\partial b_i^I \partial P_i} b_i^I \\ \frac{\partial^2 C_P}{\partial P_i^2}\tilde{r}_i K_i + \frac{\partial^2 C_P}{\partial b_i^I \partial P_i} + \frac{\partial^2 C_I}{\partial P_i^2}\tilde{r}_i K_i^2 + \frac{\partial^2 C_I}{\partial b_i^I \partial P_i} K_i & \frac{\partial^2 C_P}{\partial P_i^2} b_i^I K_i + \frac{\partial^2 C_I}{\partial P_i^2} b_i^I K_i^2 \end{pmatrix} \begin{pmatrix} db_i^I \\ d\tilde{r}_i \end{pmatrix} = \begin{pmatrix} \frac{1-t_1}{(1-t_i)^2} r \\ \frac{1-t_1}{(1-t_i)^2} \end{pmatrix} dt_i - \begin{pmatrix} \frac{\partial^2 C_P}{\partial b_i^I \partial \alpha_i}\frac{1}{K_i} \\ \frac{\partial^2 C_P}{\partial P_i \partial \alpha_i} \end{pmatrix} d\alpha_i - \begin{pmatrix} \frac{\partial^2 C_I}{\partial b_i^I \partial \sigma_i} \\ \frac{\partial^2 C_I}{\partial P_i \partial \sigma_i} K_i \end{pmatrix} d\sigma_i. \qquad (24)$$

The second-order condition implies

$$\begin{aligned} SOC &= \left[\frac{\partial^2 C_I}{\partial (b_i^I)^2} + \frac{\partial^2 C_I}{\partial b_i^I \partial P_i}\tilde{r}_i K_i + \frac{\partial^2 C_P}{\partial (b_i^I)^2}\frac{1}{K_i} + \frac{\partial^2 C_P}{\partial b_i^I \partial P_i}\tilde{r}_i\right]\left[\frac{\partial^2 C_P}{\partial P_i^2} b_i^I K_i + \frac{\partial^2 C_I}{\partial P_i^2} b_i^I K_i^2\right] \\ &- \left[\frac{\partial^2 C_P}{\partial P_i^2}\tilde{r}_i K_i + \frac{\partial^2 C_P}{\partial b_i^I \partial P_i} + \frac{\partial^2 C_I}{\partial P_i^2}\tilde{r}_i K_i^2 + \frac{\partial^2 C_I}{\partial b_i^I \partial P_i} K_i\right]\left[\frac{\partial^2 C_I}{\partial b_i^I \partial P_i} b_i^I K_i + \frac{\partial^2 C_P}{\partial b_i^I \partial P_i} b_i^I\right] > 0. \end{aligned} \tag{25}$$

Applying Cramer's rule, we finally receive for internal debt

$$\frac{db_i^I}{dt_i} = \frac{(1-t_1)\left[\frac{\partial^2 C_P}{\partial P_i^2} r b_i^I K_i + \frac{\partial^2 C_I}{\partial P_i^2} r b_i^I K_i^2 - \frac{\partial^2 C_I}{\partial b_i^I \partial P_i} b_i^I K_i - \frac{\partial^2 C_P}{\partial b_i^I \partial P_i} b_i^I\right]}{(1-t_i)^2 SOC} \begin{cases} > 0, & if \quad \frac{\partial^2 C_I}{\partial b_i^I \partial P_i} < 0, \\ \gtrless 0, & if \quad \frac{\partial^2 C_I}{\partial b_i^I \partial P_i} > 0, \end{cases} \tag{26}$$

$$\frac{db_i^I}{d\sigma_i} = \frac{-\frac{\partial^2 C_I}{\partial b_i^I \partial \sigma_i}\left[\frac{\partial^2 C_P}{\partial P_i^2} b_i^I K_i + \frac{\partial^2 C_I}{\partial P_i^2} b_i^I K_i^2\right] + \frac{\partial^2 C_I}{\partial P_i \partial \sigma_i} K_i \left[\frac{\partial^2 C_I}{\partial b_i^I \partial P_i} b_i^I K_i + \frac{\partial^2 C_P}{\partial b_i^I \partial P_i} b_i^I\right]}{(1-t_i)^2 SOC} \begin{cases} < 0, & if \quad \frac{\partial^2 C_I}{\partial b_i^I \partial P_i} < 0 \quad or \quad \frac{\partial^2 C_I}{\partial P_i \partial \sigma_i} = 0, \\ \gtrless 0, & if \quad \frac{\partial^2 C_I}{\partial b_i^I \partial P_i} > 0, \end{cases} \tag{27}$$

$$\frac{db_i^I}{d\alpha_i} = \frac{-\frac{\partial^2 C_P}{\partial b_i^I \partial \alpha_i}\left[\frac{\partial^2 C_P}{\partial P_i^2} b_i^I + \frac{\partial^2 C_I}{\partial P_i^2} b_i^I K_i\right] + \frac{\partial^2 C_P}{\partial P_i \partial \alpha_i}\left[\frac{\partial^2 C_I}{\partial b_i^I \partial P_i} b_i^I K_i + \frac{\partial^2 C_P}{\partial b_i^I \partial P_i} b_i^I\right]}{(1-t_i)^2 SOC} \begin{cases} < 0, & if \quad \frac{\partial^2 C_I}{\partial b_i^I \partial P_i} < 0. \\ \gtrless 0, & if \quad \frac{\partial^2 C_I}{\partial b_i^I \partial P_i} > 0. \end{cases} \tag{28}$$

The effects on manipulating the interest rates for transfer pricing are

$$\frac{d\tilde{r}_i}{dt_i} = \frac{(1-t_1)}{(1-t_i)^2 SOC}\left[\frac{\partial^2 C_I}{\partial (b_i^I)^2} + \frac{\partial^2 C_P}{\partial (b_i^I)^2}\frac{1}{K_i} - \left(\frac{\partial^2 C_P}{\partial P_i^2} + \frac{\partial^2 C_I}{\partial P_i^2} K_i\right)\tilde{r}_i r K_i - \left(\frac{\partial^2 C_I}{\partial b_i^I \partial P_i} K_i + \frac{\partial^2 C_P}{\partial b_i^I \partial P_i}\right)(r - \tilde{r}_i)\right] \gtrless 0, \tag{29}$$

$$\begin{aligned} \frac{d\tilde{r}_i}{d\sigma_i} &= \frac{-1}{SOC}\left[\frac{\partial^2 C_I}{\partial P_i \partial \sigma_i} K_i \left(\frac{\partial^2 C_I}{\partial (b_i^I)^2} + \frac{\partial^2 C_P}{\partial (b_i^I)^2}\frac{1}{K_i}\right) - \frac{\partial^2 C_I}{\partial b_i^I \partial \sigma_i}\left(\frac{\partial^2 C_P}{\partial b_i^I \partial P_i} + \frac{\partial^2 C_I}{\partial b_i^I \partial P_i} K_i\right) - \frac{\partial^2 C_I}{\partial b_i^I \partial \sigma_i}\left(\frac{\partial^2 C_P}{\partial P_i^2} + \frac{\partial^2 C_I}{\partial P_i^2} K_i\right)\tilde{r}_i K_i \right. \\ &+ \left. \frac{\partial^2 C_I}{\partial P_i \partial \sigma_i}\left(\frac{\partial^2 C_I}{\partial b_i^I \partial P_i} K_i + \frac{\partial^2 C_P}{\partial b_i^I \partial P_i}\right)\tilde{r}_i K_i\right] \gtrless 0, \end{aligned} \tag{30}$$

$$\frac{d\tilde{r}_i}{d\alpha_i} = \frac{-1}{SOC}\left[\frac{\partial^2 C_P}{\partial P_i \partial \alpha_i}\left(\frac{\partial^2 C_I}{\partial (b_i^I)^2} + \frac{\partial^2 C_P}{\partial (b_i^I)^2}\frac{1}{K_i}\right) - \frac{\partial^2 C_P}{\partial b_i^I \partial \alpha_i}\frac{1}{K_i}\left(\frac{\partial^2 C_P}{\partial b_i^I \partial P_i} + \frac{\partial^2 C_I}{\partial b_i^I \partial P_i}K_i\right) - \frac{\partial^2 C_P}{\partial b_i^I \partial \alpha_i}\left(\frac{\partial^2 C_P}{\partial P_i^2} + \frac{\partial^2 C_I}{\partial P_i^2}K_i\right)\tilde{r}_i \right.$$
$$\left. + \frac{\partial^2 C_P}{\partial P_i \partial \alpha_i}\left(\frac{\partial^2 C_I}{\partial b_i^I \partial P_i}K_i + \frac{\partial^2 C_P}{\partial b_i^I \partial P_i}\right)\tilde{r}_i\right] \gtrless 0. \quad (31)$$

The effects on interest-rate manipulation are ambiguous in all cases, since the level of shifted profits also depends on internal leverage b_i^I. For example, a higher tax rate induces more profit shifting (first terms in squared bracket in equation (29)). However, since a higher internal leverage also increases profit shifting $P_i = \tilde{r}_i \cdot b_i^I \cdot K_i$, there is also a negative effect on the interest rate $\tilde{r}_i$ (the first term in brackets in the squared bracket in (29)). Finally, we have the cross effects on marginal costs, which can enforce or reduce the former effects (see last term in squared bracket).

Focusing on total profit shifting P_i, the effects simplify and become as expected. Since total profit shifting is given by $P_i = \tilde{r}_i \cdot b_i^I \cdot K_i$, we find:

$$\frac{dP_i}{dt_i} = \frac{d\tilde{r}_i}{dt_i}b_i^I K_i + \frac{db_i^I}{dt_i}\tilde{r}_i K_i = \frac{1-t_1}{(1-t_i)^2 SOC}\left[\left(\frac{\partial^2 C_I}{\partial (b_i^I)^2}K_i + \frac{\partial^2 C_P}{\partial (b_i^I)^2}\right)b_i^I - \left(\frac{\partial^2 C_I}{\partial b_i^I \partial P_i}K_i + \frac{\partial^2 C_P}{\partial b_i^I \partial P_i}\right)P_i\right]\begin{cases} > 0, & if \ \frac{\partial^2 C_I}{\partial b_i^I \partial P_i} < 0, \\ \gtrless 0, & if \ \frac{\partial^2 C_I}{\partial b_i^I \partial P_i} > 0, \end{cases} \quad (32)$$

$$\frac{dP_i}{d\sigma_i} = \frac{d\tilde{r}_i}{d\sigma_i}b_i^I K_i + \frac{db_i^I}{d\sigma_i}\tilde{r}_i K_i = \frac{-1}{SOC}\left[\frac{\partial^2 C_I}{\partial P_i \partial \sigma_i}\left(\frac{\partial^2 C_I}{\partial (b_i^I)^2}K_i + \frac{\partial^2 C_P}{\partial (b_i^I)^2}\right)b_i^I K_i - \frac{\partial^2 C_I}{\partial b_i^I \partial \sigma_i}\left(\frac{\partial^2 C_I}{\partial b_i^I \partial P_i}K_i + \frac{\partial^2 C_P}{\partial b_i^I \partial P_i}\right)b_i^I K_i\right]\begin{cases} < 0, & if \ \frac{\partial^2 C_I}{\partial b_i^I \partial P_i} < 0, \\ \gtrless 0, & if \ \frac{\partial^2 C_I}{\partial b_i^I \partial P_i} > 0, \end{cases} \quad (33)$$

$$\frac{dP_i}{d\alpha_i} = \frac{d\tilde{r}_i}{d\alpha_i}b_i^I K_i + \frac{db_i^I}{d\alpha_i}\tilde{r}_i K_i = \frac{-1}{SOC}\left[\frac{\partial^2 C_P}{\partial P_i \partial \alpha_i}\left(\frac{\partial^2 C_I}{\partial (b_i^I)^2}K_i + \frac{\partial^2 C_P}{\partial (b_i^I)^2}\right)b_i^I - \frac{\partial^2 C_P}{\partial b_i^I \partial \alpha_i}\left(\frac{\partial^2 C_I}{\partial b_i^I \partial P_i}K_i + \frac{\partial^2 C_P}{\partial b_i^I \partial P_i}\right)b_i^I\right]\begin{cases} < 0, & if \ \frac{\partial^2 C_I}{\partial b_i^I \partial P_i} < 0. \\ \gtrless 0, & if \ \frac{\partial^2 C_I}{\partial b_i^I \partial P_i} > 0. \end{cases} \quad (34)$$

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