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Capital Taxation and Imperfect Competition: ACE vs. CBIT

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Abstract

This paper studies the market and welfare effects of two main tax reforms – the Corporate Business Income Tax (CBIT) and the Allowance for Corporate Equity tax (ACE). Using an imperfect-competition model for a small open economy, it is shown that the well-known neutrality property of ACE does not hold. Both corporate tax regimes distort market entry and equilibrium prices. A main result is that a small open economy should levy a positive source tax on capital in markets with free firm entry. Which tax system is better from a welfare point of view, depends on production technology, the competitive effects of ACE and CBIT, and whether entry is excessive or suboptimal at the given corporate tax rate. Imposing tax income neutrality yields a higher corporate tax rate with ACE, which increases the scope for CBIT to be welfare improving.

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1 Introduction

Imperfect competition is widespread in markets yet the literature on corporate taxation and imperfect competition is scant. This paper sets up an imperfect-competition model of a small open economy and studies the market and welfare effects of the two most favored candidates for a (fundamental) corporate tax reform, the Corporate Business Income Tax (CBIT) and the Allowance for Corporate Equity tax (ACE).[1] Under an ACE tax, the current deductibility of actual interest payments is maintained, but the system adds to this a notional return on equity to be deductible against corporate profits. In contrast, under a CBIT tax, firms cannot deduct interest payments at all. Corporate tax reform under either of these two schemes have in common that they lead to neutrality between debt and equity finance, but the tax base is narrower under an ACE tax due to the allowance for equity.

We find that that the benchmark result in the optimal tax literature that a small open economy should not levy any source-based taxes on capital,[2] is no longer valid under imperfect competition. The reason is that the corporate tax rate plays a key role in regulating competition (avoiding socially excessive market entry). When the number of firms is fixed, we show that the ACE tax is equal to a lump-sum tax in that it does not distort prices. This results has a parallel to Boadway and Bruce (1984) who pointed out that the ACE tax works like a lump-sum tax, since it offsets the investment distortions caused by deviations between true economic depreciation and depreciation for tax purposes. With free entry of firms the price neutrality under ACE taxation vanishes and both ACE and CBIT tax systems distort the market equilibrium.

Which tax system is better from a welfare point of view (ACE or CBIT) depends on assumptions about production technology, entry of firms, and the level of taxation. Under both systems, the optimal corporate tax rate is positive in order to reduce excessive entry. Though consumer prices are always lower under an ACE system, a CBIT system promotes less entry under increasing returns to scale. The reason is that CBIT avoids a subsidy on average capital costs, which under increasing returns to scale would overcompensate the intensified strategic price competition driven by the marginal-cost effect. These results are reversed under decreasing returns to scale. Empirical evidence points to that multinationals operate under increasing returns to scale (e.g., Carr et al., 2001; Antweiler and Trefler, 2002) suggesting that the ACE system leads to more entry and excessive competition.

These results are obtained by using the Salop model (Salop, 1979), which considers price competition with differentiated products in an imperfectly competitive market.

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[1]The 'Swedish Committee on Corporate Taxation', an advisory committee to the Swedish government, proposed in June 2014 that Sweden should implement the CBIT system of taxation (see SOU2014:40). Belgium and Italy have recently implemented variants of the ACE tax into their tax systems.

[2]See, e.g., Gordon (1986).

Firms pay a fixed cost to enter the market and choose the set of product characteristics to offer to consumers on the Salop circle. Since products are horizontally differentiated and consumers have a preferred variety, each firm has some market power relatively to competitors. The Salop model has the crucial property that prices and profit margins are affected by entry. Hence, strategic interactions between firms are central to the model. These features allows us to determine whether the free-entry equilibrium has too much, or too little variety, relative to the social optimum.

An alternative model to the Salop model would be the Dixit and Sitglitz (1977) monopolistic competition model. A weakness of this model is that it does not consider strategic interactions between firms, since firm's prices are always a constant mark-up over marginal costs. Consequently, changes in tax rates do not change firms' price strategies since the adjustment comes via the number of firms in the market. In the Dixit-Stiglitz model taxes reduce firm's profit and induces some firms to exit the market, but taxes do not affect market prices (they remain constant). These limiting features of the Dixit-Stiglitz model makes it a less obvious candidate for our analysis, especially since our focus is on the strategic interaction between firms.

1.1 Related literature

The comprehensive business income tax (CBIT) and the allowance for corporate equity (ACE) have recently gained interest in European policy debates as a way of restructuring corporate tax due to perceived losses in welfare that follows from current corporate tax systems. Most countries allow for a deduction of debt interest when computing the profit tax base, but disallow equity to deduct its opportunity cost. Debt finance, therefore, is at an advantage compared to financing an investment via retained earnings or equity. This may lead to too much debt, too high risk premiums being paid, or moral hazard problems (excessive risk taking or suboptimal investments; see, e.g., Myers, 1977). In order to avoid such problems and to equalize the opportunity cost of debt and equity, CBIT and ACE taxation came into being.[3]

CBIT was developed by the US Treasury Department at the beginning of the nineties (see US Department of Treasury, 1992), whereas the ACE was elaborated by the IFS Capital Taxes Group (see Institute for Fiscal Studies, 1991). The CBIT makes the corporation tax neutral towards the financing structure by disallowing the exemption of interest paid for corporate income tax purposes. ACE obtains the same result by granting equity holders an allowance equal to a notional risk-free return on equity (e.g., the market interest rate for long-term government bonds). Neither the comprehensive business income tax nor the allowance for corporate equity distort the liability side of

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[3]A recent proponent for financing neutrality is the Mirrlees Report; see Mirrlees et al. (2011), particularly chapter 17.

corporations. One key difference between the two systems is that CBIT has a wider tax base (since interest expenses are non-deductible), but distorts marginal investment decisions compared to ACE.

Previous studies of these two tax systems have been undertaken in a perfectly competitive setting. Radulescu and Stimmelmayr (2007) compare ACE and CBIT using computable general equilibrium (CGE). They show that welfare is higher under an ACE type of reform even if the loss of tax revenue is financed by an increase in the VAT. De Mooij and Devereux (2011) use an applied general equilibrium model for the EU calibrated with recent empirical estimates of elasticities to study a balanced budget reform. They focus on investment and profit shifting incentives following a tax reform and find that most European countries would benefit from a unilateral CBIT type of reform. A coordinated tax reform within the EU, however, would work in favor of an ACE reform.

Keuschnigg and Ribi (2013) use a model of competitive markets and show that if firms are cash-constrained, an ACE tax will affect investment decisions. However, the ACE tax still remains less distortive than a CBIT system. Köthenbürger and Stimmelmayr (2014) study how agency problems (such as empire building) are affected by systems of corporate taxation. They find that, depending on how severe the internal agency problem is and to which extent it can be mitigated by external (bank) monitoring, financing cost allowances (such as an ACE tax) may hamper welfare.

The model used in this paper is the circular city model of Salop, and in the subsequent sections, we set up the model and analyze the equilibrium with and without free entry of firms. In the final section of the paper, a welfare comparison of the two tax systems is undertaken.

2   Model

Consider a market with $n \geq 2$ firms symmetrically located on a (Salop) circle with circumference equal to 1. Each firm offers a product at price p_i, $i = 1, ..., n$. There is a continuum of consumers uniformly located on the circle with total mass normalized to one. Each consumer buys one or zero units of the product. The utility to consumer located at $x \in [0, 1]$ of buying product i is given by

$$u_i = v - \tau d_i + \phi, \tag{1}$$

where v is the gross utility of consuming the product (reservation price), τ is the transport cost per unit of distance, $d_i = |z_i - x|$ is the distance to firm i's location $z_i \in [0, 1]$, and ϕ is a numeraire good. Distance is, as usual, interpreted either in physical or product

space.[4]

Each consumer has income $m = r\kappa + w$, where $r\kappa$ is capital income, with r denoting the interest rate and κ the capital endowment, and w is non-capital (e.g., labor) income. We assume a small, open economy, which implies that r is exogenous and the firms' demand for capital is not constrained by the domestic capital endowment. Normalizing the price of the numeraire good to unity, and inserting the budget constraint into (1), we can write the net utility of consumer x as follows

$$u_i = v - \tau d_i - p_i + m. \tag{2}$$

We assume v is sufficiently large, so that all consumers buy one unit of the product from the most preferred firm (full market coverage). The consumer that is indifferent between buying from firm i and firm $i + 1$ is located at

$$\widehat{x}_+ = \frac{1}{2\tau} \left[\tau \left(z_{i+1} + z_i \right) - p_i + p_{i+1} \right],$$

whereas the consumer indifferent between buying from firm i and firm $i - 1$ is located at

$$\widehat{x}_- = \frac{1}{2\tau} \left[\tau \left(z_i + z_{i-1} \right) + p_i - p_{i-1} \right].$$

Firm i's demand is then given by

$$y_i = \int_{\widehat{x}_-}^{\widehat{x}_+} dx = \frac{1}{n} - \frac{2p_i - p_{i-1} - p_{i+1}}{2\tau}. \tag{3}$$

The firms have identical technology. For simplicity, we assume capital is the only input in production and define the relationship between capital and production by the following inverse production function $k_i = g\left(y_i\right)$.[5] The inverse production function $g\left(.\right)$ is assumed to be continuous and twice differentiable, where $g\left(0\right) = 0$ and $g'\left(.\right) > 0$. We allow for technology to exhibit different scale properties. A constant returns to scale (CRS) technology implies constant marginal productivity of capital, $g'' = 0$, and marginal capital costs equal to average capital costs, $g' = g/y$. Decreasing returns to scale (DRS) technology implies decreasing marginal productivity of capital, $g'' > 0$, and marginal capital costs exceeding average capital costs, $g' > g/y$, whereas the opposite is true for an increasing returns to scale (IRS) technology.[6]

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[4]In the latter case, τ is often referred to as the mismatch cost measuring the cost related to the distance between the consumer's most preferred product (defined by the consumer's location x) and the products offered in the market (defined by the firm location z).

[5]This production function can be generalized to encompass non-capital inputs (labor) when these inputs are used either in fixed proportions with or independently of capital.

[6]To see this more clearly, consider the production function $y = f\left(k\right) = k^{1/\theta}$, where $\theta > 0$. Clearly, if $\theta = 1$, technology is CRS with constant marginal productivity of capital, whereas if $\theta < (>) 1$, technology is IRS (DRS) with increasing (decreasing) marginal capital productivity. Inverting the production

We assume a perfectly competitive capital market and, for simplicity, that neither equity nor debt are risky. This implies that the interest rates of debt and equity must be equalized in a capital market equilibrium. Thus, firms are indifferent between raising capital through debt or equity and the cost of capital is given by the interest rate in the capital market. Firm i's gross (before-tax) profits can be expressed by

$$\pi_i = p_i y_i - r g\left(y_i\right) - f, \tag{4}$$

where $p_i y_i$ is sales revenues, r is the interest rate, $r g\left(y_i\right)$ is capital costs, and $f > 0$ is fixed set-up (entry) costs assumed without loss of generality to be identical across firms.[7]

The corporate tax scheme is set by the government. We will consider two different regimes: (i) Comprehensive Business Income Tax (CBIT) and (ii) Allowance for Corporate Equity (ACE). The two regimes differ according to whether they allow for tax deduction of capital costs. While ACE allows for tax deductions of both debt and equity, CBIT does not allow for any tax deductions of capital costs. Firm i's after-tax profits are given by

$$\pi_i = (1 - t)\, p_i y_i - r\left(1 - \alpha t\right) g\left(y_i\right) - f, \tag{5}$$

where $t \in [0, 1)$ is the corporate tax rate and $\alpha \in [0, 1]$ is the share of the capital costs that are tax deductible by the firms. Note that the term $(1 - \alpha t)$ is the difference between true costs and tax deductible capital costs. $\alpha = 0$ corresponds to a pure CBIT scheme with no tax deductions for capital costs, whereas $\alpha = 1$ mimics an ACE-system with tax deductibility for all capital costs.

We consider the following timing structure. At stage 1, the tax authority decides on the corporate tax rate and the tax deductions for capital costs. At stage 2, the firms simultaneously decide to enter the market. Entry takes place as long as expected operating profits exceed the fixed (sunk) entry cost. Finally, at stage 3, the firms that entered the market compete in prices à la Bertrand. The game is as usual solved by backward induction.

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function above, we get $k = g\left(y\right) = y^\theta$, where

$$g' = \theta y^{\theta - 1},\ g'' = \theta\left(\theta - 1\right) y^{\theta - 2},\ \text{and}\ g' - g/y = y^{\theta - 1}\left(\theta - 1\right).$$

Thus, a CRS technology ($\theta = 1$) implies $g'' = 0$ and $g' = g/y$, a DRS technology ($\theta > 1$) implies $g'' > 0$ and $g' > g/y$, and an IRS technology ($\theta < 1$) implies $g'' < 0$ and $g' < g/y$.

[7]Allowing for different fixed costs would imply that only firms with sufficiently low fixed costs would enter. However, since the fixed costs do not influence the price decisions directly, but only entry decision, our results would be robust to such a generalization.

3 Price equilibrium

Given that $n \geq 2$ firms have entered the market, each firm sets the price in order to maximize profits taking the other firms' prices as given. The profit-maximizing price of firm i is given by the following first-order condition:[8]

$$\frac{\partial \pi_i}{\partial p_i} = (1-t)\left(p_i \frac{\partial y_i}{\partial p_i} + y_i\right) - r(1-\alpha t) g'(y_i) \frac{\partial y_i}{\partial p_i} = 0, \tag{6}$$

where $\partial y_i / \partial p_i = -1/\tau$ from equation (3).

Imposing symmetry, i.e., $p_i = p_{i-1} = p_{i+1} = p$ for all $i = 1, ..., n$, and solving (6) for p, we get the following candidate for a symmetric Nash price equilibrium

$$p^* = \frac{\tau}{n} + r g'(y_i)\left(\frac{1-\alpha t}{1-t}\right). \tag{7}$$

The last term can be interpreted as the (effective) marginal capital costs, which is increasing in the corporate tax rate, but decreasing in the level of tax deductions. Inserting (7) into (5), we get the following equilibrium after-tax profits

$$\pi^* = (1-t)\frac{\tau}{n^2} + r(1-\alpha t)\left(g'\frac{1}{n} - g\right) - f. \tag{8}$$

From these expressions, we can establish the following:

Lemma 1 *The price equilibrium in (7) exists and is unique if and only if $\tau > \max\{\tau_1, \tau_2\}$, where*

$$\tau_1 = -\frac{r}{2}\frac{1-t\alpha}{1-t}g'' \tag{9}$$

ensures that the profit function is strictly concave, and

$$\tau_2 = \frac{n^2}{1-t}\left(r(1-\alpha t)\left(g - g'\frac{1}{n}\right) + f\right) \tag{10}$$

ensures that each firm's equilibrium after-tax profits are non-negative.

All proofs are provided in the Appendix.

The effects of corporate taxation follow from (7);

$$\frac{\partial p^*}{\partial t} = r g' \frac{1-\alpha}{(1-t)^2} \geq 0, \tag{11}$$

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[8] The second-order condition requires

$$\frac{\partial^2 \pi_i}{\partial p_i^2} = -\frac{1}{\tau}\left[2(1-t) + r(1-\alpha t) g'' \frac{1}{\tau}\right] < 0.$$

$$\frac{\partial p^*}{\partial \alpha} = -rg'\frac{t}{1-t} < 0, \tag{12}$$

which allows us to state:

Proposition 1 *In a Salop model with a fixed number of firms,*

(i) *a higher corporate tax rate increases product prices for incomplete capital cost deductions ($\alpha < 1$). Only if complete tax deductions for capital costs are allowed ($\alpha = 1$), the corporate tax has no distortionary price effects.*

(ii) *a higher level of tax deduction for capital costs (α) always reduces product prices.*

If the tax authority introduces CBIT in its pure form with no tax deductions ($\alpha = 0$) or only allows for limited deductions of capital costs ($\alpha < 1$), we obtain the standard result that the corporate tax distorts firm behavior and thus product prices. The effect of corporate taxation on product prices can be decomposed into a direct and a strategic effect. The direct effect is that the corporate tax increases the (effective) marginal cost of capital, which in turn shifts up the product prices.[9] The strategic effect is due to prices being strategic complements and reinforces the direct effect of corporate taxation on product prices.[10] Thus, corporate taxation has a stronger (positive) impact on product prices in markets with imperfect price competition than in markets without any strategic interaction between firms.

Under an ACE tax scheme with complete tax deductions for capital costs ($\alpha = 1$), the corporate tax does not distort product prices. The reason is that when all capital costs can be deducted from the tax base, then corporate taxation is equivalent to a lump-sum profit tax. Consequently, the corporate tax will not have any impact on the firms' pricing decisions. This is in line with the neutrality properties that has been attributed to the ACE system.[11] As will be clear later, this result is only true when the number of firms in the market is fixed.

What are the effects of corporate taxation and the tax deduction scheme on firm profitability? Differentiating (8) with respect to t and α, and using the equilibrium conditions (9)-(10), yields

$$\frac{\partial \pi^*}{\partial t} = -\frac{\tau}{n^2} - \alpha r \left(g'\frac{1}{n} - g \right) < 0, \tag{13}$$

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[9]Alternatively, we can think of a higher corporate tax rate as a reduction of firms' marginal revenues, which induces the firms to increase their prices in order to balance marginal revenues and marginal cost.

[10]The individual firm response to corporate taxation is obtained by differentiating (6) with respect to t yielding:

$$\frac{\partial p_i}{\partial t} = \frac{y_i - \frac{1}{\tau}(p_i + \alpha rg')}{\frac{1}{\tau}\left(2(1-t) + r(1-\alpha t)\frac{1}{\tau}g''\right)}.$$

[11]See, e.g., Boadway and Bruce (1984).

$$\frac{\partial \pi^*}{\partial \alpha} = -rt\left(g'\frac{1}{n} - g\right) \gtrless 0. \tag{14}$$

Based on these expressions, we get the following results:

Proposition 2 *In a Salop model with a fixed number of firms,*

(i) *a higher corporate tax rate always reduces firms' after-tax profits. Under CBIT ($\alpha = 0$), profits always fall independently of production technology. If capital cost deductions are allowed ($\alpha > 0$), then the negative effect on firm's profit is stronger under DRS technology and weaker under IRS technology.*

(ii) *a higher level of tax deduction for capital costs increases (reduces) firms' after-tax profits if the technology is IRS (DRS), but has no effect on after-tax profits if technology is CRS.*

Proposition 2 makes it clear that a higher corporate tax rate reduces firms' after-tax profits. The reason is that the firms cannot shift the full burden of the corporate tax onto consumers. A higher corporate tax rate increases the price to consumers, but the rise is not sufficient to recover the loss in profit from the corporate tax payment. The fall in profit holds for any production technology (IRS, DRS or CRS).

If the tax authority disallows tax deductions of capital costs, as under CBIT ($\alpha = 0$), then from (13) we see that the production technology does not play a role for the effect of the corporate tax on firms' profits. If tax deductions are allowed ($\alpha > 0$), the technology relating capital and production matters. More precisely, the higher (lower) are the marginal capital costs relative to the average capital costs, the stronger (weaker) is the negative impact of corporate taxation on firms' after-tax profits. In other words, corporate taxation is particularly harmful to firms' profits when the tax authority allows for tax deductions and production involves DRS. However, if technology involves IRS, then the negative effect on profits of corporate taxation is partly mitigated by the reduction in capital costs due to tax deductions.

To see why scale in production matters for profit, it is useful to decompose the effect of the corporate tax into three separate effects; (i) a loss in sales revenues ($-tp^*y^*$); (ii) an increase in prices ($\partial p^*/\partial t$) $(1-t)\,y^*$; and (iii) a reduction in capital costs ($\alpha r g\,(y^*)$) due to tax deductions. The two first effects depend on the size of the marginal cost of capital (scaled with the production level), whereas the latter effect depends on the total capital costs. Thus, the smaller the marginal costs are relative to the average costs, the stronger is the capital cost gain from tax deductions.

The effect of tax deductions of capital costs on firms' after-tax profits crucially hinges on the production technology, as shown in Proposition 2. Surprisingly, a higher level of tax deductions may result in lower after-tax profits to the firms if the technology is DRS. To understand this result, we can decompose the total effect of the tax deduction into

two separate effects: (i) a profit loss due to lower prices, $(1-t) \, y^* \, (\partial p^*/\partial \alpha)$, and (ii) a profit gain due to lower capital costs, $(rt) \, g \, (.)$. The latter effect is the direct tax saving effect of the tax deduction, whereas the former effect is a strategic effect due to price competition. If the technology is CRS, these two effects cancel each other, and the net effect of tax deductions is zero and the choice of ACE versus CBIT does not matter for firms' profitability. On the other hand, if the technology is IRS, the direct effect (capital cost gain) dominates, and the net effect of tax deductions on profits is positive. Thus, a ACE scheme would be more beneficial to the firms than CBIT. If the technology is DRS, however, the strategic (price) effect dominates, and the effect of tax deductions on profits is negative, suggesting that CBIT is more beneficial to firms than ACE.

4 Free entry equilibrium

We now consider stage 2 where $n \geq 2$ firms simultaneously decide whether or not to enter the market. Each firm i enters the market if the expected profits exceed the fixed (sunk) entry cost $f > 0$. Firms enter the market until the equilibrium after-tax profits equal zero (up to the integer problem); hence, the equilibrium number of firms $n^* \, (t, \alpha; \tau, f, r)$ is given by

$$\pi^* = (1-t) \, \frac{\tau}{(n^*)^2} + r \, (1 - \alpha t) \left(g' \frac{1}{n^*} - g \right) - f = 0. \tag{15}$$

How do the corporate tax and tax deductions affect the number of firms in the market? The answer to this question follows qualitatively from the results in Proposition 2. Quantitatively, by applying the implicit function theorem on (15), and using the equilibrium conditions (9)-(10), we obtain the following tax effects on the number of firms

$$\frac{\partial n^*}{\partial t} = - (n^*)^3 \, \frac{\frac{\tau}{(n^*)^2} + r\alpha \left(g' \frac{1}{n^*} - g \right)}{(1-t) \, 2\tau + r \, (1 - \alpha t) \, g''} < 0, \tag{16}$$

$$\frac{\partial n^*}{\partial \alpha} = - (n^*)^3 \, \frac{rt \left(g' \frac{1}{n^*} - g \right)}{(1-t) \, 2\tau + r \, (1 - \alpha t) \, g''} \gtrless 0. \tag{17}$$

Based on these expressions, we get the following results:

Proposition 3 *In a Salop model with free entry,*

(i) *a higher corporate tax rate always reduces the number of firms in the market, irrespective of technology and tax deduction scheme (ACE or CBIT);*

(ii) *a higher level of tax deductions of capital costs increases (reduces) the number of firms in the market when technology is IRS (DRS), but has no effect when technology is CRS.*

As expected, Proposition 3 shows that corporate taxation always reduces firm entry and therefore the intensity of competition in the market. The magnitude of this effect depends on the scale properties and whether tax deductions for capital costs are allowed or not. More interesting, Proposition 3 shows that the effect of tax deductions crucially relies on the production technology. If technology is CRS, then tax deductions have no impact on market entry, and the choice of ACE or CBIT has no competitive effect. However, if technology is DRS, then allowing for tax deductions reduces the number of firms in the market, which means that CBIT would be more pro-competitive than ACE. The opposite is true when technology is IRS. To understand this result, note that tax deductions have two opposing effects on profits. On one hand, tax deductions directly increases profits, all else equal. On the other hand, tax deductions shift down prices and thus profit margins, which reduces profits. Proposition 3 shows that the latter effect is stronger than the direct effect when technology is DRS, whereas with CRS the two effects exactly cancel out.

What are the tax effects on product prices in a market with free entry of firms? Taking the partial derivative of (7) with respect to t and α, and imposing the equilibrium level of firms $n^* (t, \alpha; \tau, r, f)$ given by (15), we get the following (implicit) comparative static results

$$\frac{\partial p^*}{\partial t} = rg' \frac{1-\alpha}{(1-t)^2} - \frac{1}{n^2} \left(\tau + r \frac{1-\alpha t}{1-t} g'' \right) \frac{\partial n^*}{\partial t} > 0, \tag{18}$$

$$\frac{\partial p^*}{\partial \alpha} = -rg' \left(\frac{t}{1-t} \right) - \frac{1}{n^2} \left(\tau + r \frac{1-\alpha t}{1-t} g'' \right) \frac{\partial n^*}{\partial \alpha} < 0. \tag{19}$$

Based on these expressions, we get the following results:

Proposition 4 *In a Salop model with free entry,*

(i) *a higher corporate tax rate always leads to higher product prices, irrespectively of technology and tax deduction scheme (ACE or CBIT);*

(ii) *a higher level of tax deductions of capital costs always reduces product prices irrespective of technology.*

When accounting for entry, corporate taxation always leads to higher prices in the product market, even with ACE and complete tax deduction of capital costs ($\alpha = 1$). The reason is that corporate taxation has both a direct effect on prices (as shown in Proposition 1) and an indirect effect through the change in entry and thus competition intensity. In equation (18), these two effects are captured by the first and second term, respectively. While ACE eliminates the direct distortionary effect on firms' pricing, the indirect effect through competition prevails. Since firms' after-tax profits are inevitably affected by corporate taxation, intensity of competition will be reduced. Thus, corporate

taxation has distortionary effects on product prices irrespective of whether ACE or CBIT is introduced.

The indirect effect of corporate taxation, as given by the second term in (18), consists of two elements; (i) a standard competition effect (τ/n^2), and (ii) a capital cost effect $(rg''(1-\alpha t)/(1-t))$. With a CRS technology, the cost effect vanish, whereas with an IRS (a DRS) technology the cost effect strengthen (dampen) the competition effect on prices.

Tax deductions of capital costs always reduces product prices, even when accounting for entry. We know from Proposition 1 that tax deductions reduce product prices for a given number of firms. However, as shown in Proposition 3, the competition effects of tax deductions are ambiguous and depend on the production technology. Indeed, if technology exhibits DRS, then higher levels of tax deductions reduce entry and shift up product prices. However, we find that this potentially countervailing competition effect only partially mitigates the direct effect, and that tax deductions always lead to lower product prices.

Based on the previous results, we may sum up the findings related to the choice of the tax deduction regime in the following way:

Corollary 1 *In a Salop model with free entry,*

(i) *CBIT (ACE) promotes more entry of firms when technology exhibits DRS (IRS);*

(ii) *both ACE and CBIT distort product prices, but ACE induces lower product prices than CBIT, irrespective of technology.*

5 Social welfare and corporate taxation

Social welfare, assuming a utilitarian (unweighted) welfare function, is given by the sum of consumers' surplus, producers' profits, and (in this setting) the corporate tax income, i.e.,

$$W = CS + \Pi + T. \tag{20}$$

CS represents the consumers' surplus given by

$$CS = \sum_{i=1}^{n} \int_{\widehat{x}_{i-1}}^{\widehat{x}_{i+1}} (v - \tau d_i - p_i + m)\,dx, \tag{21}$$

Π is the producers' profits given by

$$\Pi = \sum_{i=1}^{n} \pi_i = \sum_{i=1}^{n} \left[(1-t)\,p_i y_i - r\,(1-\alpha t)\,g\,(y_i) - f\right], \tag{22}$$

and T is the corporate tax income given by

$$T = \sum_{i=1}^{n} \left[tp_i y_i - \alpha r t g\left(y_i\right) \right].$$ (23)

Using this specification of social welfare, we derive the first-best outcome, as a benchmark. After that, we study the tax authority's optimal choice of corporate taxation and deductions (ACE or CBIT), and the corresponding effects on entry and pricing in the product market. Finally, we analyze the welfare properties of ACE and CBIT under tax income neutrality, i.e., the two schemes have to generate the same tax income level.

5.1 First-best outcome

Consider a social planner that directly decides the number of firms and their production levels using the available technology. Since firms are symmetric, the first-best outcome implies that each firm produces $1/n$ units of the product. Inserting (21)-(23) into and imposing symmetry, the social welfare function in (20) simplifies to

$$W^{fb} = m + v - \frac{\tau}{2n} - nrg\left(y\right) - nf,$$ (24)

where the first three terms are the (gross) consumers' surplus, and the two last terms are the capital costs and the fixed costs of setting up n firms.

The social planner chooses the number of firms that maximizes social welfare in (24), yielding[12]

$$\frac{\partial W^{fb}}{\partial n} = \frac{\tau}{2\left(n^{fb}\right)^2} + r\left(g' \frac{1}{n^{fb}} - g \right) - f = 0,$$ (25)

where $n^{fb}\left(\tau, r, f\right)$ is the first-best number of firms in the market. The first term of (25) is the social marginal benefit of a new firm due to the reduction in transport costs, the second term measures the net welfare effect of technology (i.e., returns to scale) on production costs, whereas the last term is the cost of setting up one additional firm.

With a CRS technology, the marginal cost of capital is equal to the average capital cost, and the socially optimal number of firms depends only on the reduction in transportation costs relative to the increase in fixed costs. In this case, the first-best number of firms is given by $n^{fb}_{CRS} = \sqrt{\tau/2f}$. If technology is IRS ($g' < ng$), it follows from (25) that the first-best number of firms is lower than under a CRS technology, whereas if technol-

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[12]The second-order condition requires

$$\frac{\partial^2 W}{\partial n^2} = -\frac{1}{n^3}\left(\tau + rg''\right) < 0,$$

which is always fulfilled if $g'' \geq 0$. However, if $g'' < 0$, we need to assume that $\tau > -rg''$.

ogy is DRS $(g' > ng)$, the first-best number of firms is higher than with CRS technology. Thus, we have the following ranking

$$n_{IRS}^{fb} < n_{CRS}^{fb} < n_{DRS}^{fb}.$$

This ranking is also intuitive because with IRS technology, each firm should produce more output in order to exploit the scale properties so that overall production costs fall, all else equal. However, with DRS technology, it is optimal with more firms that each produces a lower volume.

5.2 Socially optimal corporate tax

In a second-best world, the number of firms is determined by the market equilibrium defined by the zero-profit condition in (15). In this case, second-best welfare is simply the sum of consumers' surplus and corporate tax income. Imposing symmetry, the second-best social welfare simplifies to the following

$$W^{sb} = m + v - \frac{\tau}{2n^*} - p^* + t\left(p^* - \alpha rgn^*\right), \tag{26}$$

where p^* and n^* are given by (7) and (15), respectively. The first four terms define the net consumers' surplus, whereas the last term is the corporate tax income net of the tax deductions for capital costs.

The socially optimal corporate tax is given by the following first-order condition

$$\frac{\partial W^{sb}}{\partial t} = p^* - \alpha n^* rg - (1-t)\frac{\partial p^*}{\partial t} + \left[\frac{\tau}{2(n^*)^2} + \alpha tr\left(g'\frac{1}{n^*} - g\right)\right]\frac{\partial n^*}{\partial t}. \tag{27}$$

The two first terms define the direct welfare effect of corporate taxation keeping prices and the number of firms fixed. The third term defines the negative welfare effect of higher prices, whereas the last set of terms defines the indirect welfare effects on transport and capital costs due to changes in market entry. As shown in Proposition 3, a higher corporate tax reduces the number of firms $(\partial n^*/\partial t < 0)$, and has therefore an adverse effect on consumers' surplus, whereas the impact on capital costs depends on the production technology and level of tax deductions.

Using the equilibrium price and market entry in (7) and (15), respectively, and the comparative statics results in (18) and (16), the first-order condition in (27) simplifies to

$$\frac{\partial W^{sb}}{\partial t} = \frac{\left[\tau + n^* r\alpha\left(g' - gn^*\right)\right]\left[\tau\left(1 - 2t\right) - 2n^* rt\alpha\left(g' - gn^*\right)\right]}{2n^*\left[2\tau\left(1 - t\right) + r\left(1 - \alpha t\right)g''\right]} = 0,$$

which yields the following socially optimal corporate tax

$$t^* = \frac{1}{2}\left(\frac{\tau}{\tau + \alpha r n^* \left(g' - n^* g\right)}\right) > 0. \tag{28}$$

From this expression, we obtain the following results:

Proposition 5 *In a Salop model with free entry,*

  (i) *there exists a strictly positive (and unique) corporate tax rate t^* defined by (28) that implements first-best entry $\left(n^* = n^{fb}\right)$.*

 (ii) *If $t < (>) t^*$, then the market equilibrium implies excessive (suboptimal) entry.*

(iii) *If capital cost deductions are not allowed (CBIT) and/or technology involves CRS, the first-best corporate tax rate is 1/2;*

(iv) *If capital cost deductions are allowed (ACE) and technology involves IRS (DRS), the first-best corporate tax rate is higher (lower) than 1/2.*

In contrast to the optimal tax literature to date, Proposition 5 shows that a small open economy under imperfect competition should levy a positive corporate (source) tax on capital. In our setting, such a positive tax implies that the tax also falls on the normal return on mobile capital. The benchmark result in the optimal tax literature is that a small open economy should not apply a source-based tax on the normal rate of return on mobile capital (see Gordon, 1986). Since capital is perfectly elastic, such a source-based tax is fully shifted onto immobile factors of production via an outflow of capital which drives up the pre-tax return to capital. This result is recognized as an open-economy version of Diamond and Mirrlees' (1971) production efficiency theorem, but is derived under the assumption of perfect competition. Under imperfect competition the welfare maximization problem must balance the gains and costs of tougher competition and this leads to a positive tax rate.

In our model a zero corporate tax would result in excessive entry. This result, which is often referred to as the "excess entry theorem", is standard in spatial competition models (e.g., Vickrey, 1964; Salop, 1979).[13] The social planner equates the marginal benefit to consumers (reduction in transport costs) to the marginal costs (fixed entry cost and change in capital costs due to scale properties). Firms, on the other hand, consider the profitability of entry and do not internalize the negative impact of entry on rival firms' profit through increased price competition. Since total demand is inelastic, competition is purely business-stealing, which is the main reason for excessive entry (see, e.g., Gu

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[13]Matsumura and Okamura (2006) show that this theorem holds for a large set of transportation costs and production technologies. However, Gu and Wenzel (2009) relax the assumption of inelastic demand and show that there is insufficient entry if demand is sufficiently elastic.

and Wenzel, 2009). From a social point of view, the marginal costs of entry exceeds the marginal benefit to consumers.

To summarize our results above, we find that in markets with corporate taxation, firm entry can be excessive or suboptimal depending on the level of the corporate tax. Since the corporate tax directly reduces firms' profits, the incentive to enter the market is reduced. The corporate tax mitigates market failure due to excessive entry, and transforms the wasteful use of resources spent on market entry into tax revenues, which can be returned to households via lump-sum transfers or by financing a public good.[14]

Proposition 5 makes it clear that the tax authorities can always implement the first-best by selecting the appropriate corporate tax rate. The socially optimal tax rate is exactly 1/2 if the technology is CRS. In this case, tax deductions for capital costs do not influence the market equilibrium (market entry). However, if technology is IRS or DRS, then the choice of ACE or CBIT will influence the market outcome and therefore also the optimal corporate tax rate. More precisely, if technology is IRS, then the first-best number of firms is lower than under CRS. Consequently, the optimal corporate tax rate is higher. The reverse is true when technology is DRS.

Note that positive corporate taxation is optimal for any kind of tax system, i.e., for any level of α. In a Salop world, welfare is fully determined by the competition intensity, i.e., by the number of firms in the market. The government has two instruments, the tax rate t and the share of capital cost that are tax deductible (α) to enforce the optimal number of firms in the market. Because price effects are welfare-neutral redistributive effects between consumers and producers in our imperfect-competition model, the choice of the tax system (i.e., of α) does not provide any additional benefits and we are left with two instruments for adjusting one margin. The choice of α then is redundant as soon as the optimal corporate tax rate is adjusted according to equation (28). Under constant returns to scale, it is also important to note that corporate taxation is the only instrument available as capital cost deductibility does not affect market entry anymore.

5.3   Socially optimal capital costs deductions

Usually the corporate tax rate is not set in order to induce the first-best number of firms across product markets. In this section, we therefore study the welfare effects of tax deduction schemes assuming any given corporate tax $t \in (0, 1)$. Maximizing the second-best social welfare function in (26) with respect to the level of tax deductions for capital costs yields the following first-order condition

$$\frac{\partial W^{sb}}{\partial \alpha} = -tn^* rg - \frac{\partial p^*}{\partial \alpha}(1-t) + \left[\frac{\tau}{2(n^*)^2} + \alpha tr\left(g'\frac{1}{n} - g\right)\right]\frac{\partial n^*}{\partial \alpha}. \qquad (29)$$

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[14]Note that equilibrium profits are zero due to free market entry. Therefore, our results are not driven by the fact that economic rents should be taxed away in an optimal tax setting.

The impact of capital cost tax deductions on social welfare consists of a direct effect (first two terms) and an indirect effect through the change in entry (last set of terms). For a given number of firms, allowing for tax deductions reduces corporate tax income both directly (tn^*rg) and through the price reduction $(t^* \cdot \partial p^*/\partial \alpha)$. However, the price reduction benefits consumers, implying that the net direct welfare effects of capital cost tax deductions are a priori ambiguous.

The indirect welfare effects crucially relies on the impact of capital cost deductibility on market entry. We showed in Proposition 3 that a higher level of deductions increases (reduces) the number of firms in the market when technology is IRS (DRS), but has no effect when technology is CRS. Thus, under CRS technology, the last term in (29) disappears and we are left with the direct effect. However, with an IRS technology, ACE will trigger more market entry. In this case, capital cost deductions have a positive impact on consumers' surplus due to lower transport costs and lower prices, but a negative impact on tax income through lower prices and higher average capital costs due to lower production at each firm. The opposite is true for DRS technology or CBIT tax scheme.

Imputing the equilibrium values in (7) and (15) and the comparative statics in (19) and (17), the first-order condition simplifies to

$$\frac{\partial W^{sb}}{\partial \alpha} = \frac{rt\left(g' - gn^*\right)\left[\frac{\tau}{2}\left(1 - 2t\right) - \alpha tn^*r\left(g' - gn^*\right)\right]}{2\tau\left(1 - t\right) + rg''\left(1 - t\alpha\right)} = 0, \tag{30}$$

which yields the following optimal tax deduction level for capital costs

$$\alpha^* = \frac{\tau\left(1 - 2t\right)}{2n^*rt\left(g' - gn\right)}. \tag{31}$$

Based on these expressions, we get the following results:

Proposition 6 *In a Salop model with free entry, we may state:*
(i) If technology is CRS, the choice of tax scheme has no effect on welfare;
(ii) If technology is IRS, CBIT ($\alpha = 0$) is socially optimal if $t \leq 1/2$; ACE ($\alpha = 1$) is socially optimal if $t > \widetilde{t}$, and an intermediate scheme ($0 < \alpha < 1$) is socially optimal if $t \in \left(1/2, \widetilde{t}\right)$;
(iii) If technology is DRS, CBIT is socially optimal if $t \geq 1/2$; ACE is socially optimal if $t < \widetilde{t}$, and an intermediate scheme is socially optimal if $t \in \left(\widetilde{t}, 1/2\right)$;
where $\widetilde{t} = \tau/2\left(\tau + n^*r\left(g' - gn\right)\right)$ yields $\alpha^* = 1$.

The proposition shows that the choice of tax scheme crucially relies on the production technology and the competitive effects of ACE and CBIT. Under CRS technology, the deductibility of capital costs (interest) has no impact on market entry (cf. Proposition 3), and the choice of tax scheme is welfare neutral. However, under IRS technology, CBIT is welfare improving if the corporate tax is sufficiently low. In this case, the number of

firms in the market is too high, and full deductibility of capital costs (ACE) triggers even more entry. Consequently, IRS technology and an ACE-system is only welfare improving for high corporate tax levels when market entry is suboptimal. The opposite is true when the technology is DRS.

5.4   Tax revenue neutrality

In this section, we analyze the welfare properties of ACE and CBIT when we require that a tax reform (switching either to ACE or CBIT) must keep tax revenue unchanged. Imposing symmetry, the corporate tax income in (23) simplifies to[15]

$$T^* = t\left(p^* - \alpha r g n^*\right), \tag{32}$$

where the equilibrium price p^* and number of firms n^* are given by (7) and (15), respectively. From this we can make two observations. First, for a given number of firms, capital cost deductibility generates lower tax revenue due to the deductibility of interest and due to lower prices and lower before-tax profits. The implication is a higher corporate tax under ACE than CBIT. Second, for a given tax scheme, more firms in the market place reduces tax income. Fiercer competition reduces prices and before-tax profits, which in turn leads to lower tax revenue, all else equal. Thus, when CBIT triggers less entry than ACE, the competition effect reinforces the direct effect, and ACE requires a higher corporate tax to achieve tax income neutrality. When CBIT triggers more entry than ACE, the competition effect counteracts the direct effect, and it is a priori unclear which regime that requires a higher corporate tax to keep tax revenue unchanged. In order to study this ambiguity further, we consider the effect of a change in the corporate tax and α on the equilibrium corporate tax income. Differentiating the tax revenue expression (32) with respect to the corporate tax rate yields

$$\frac{\partial T^*}{\partial t} = p^* - \alpha r g n^* + t\left(\frac{\partial p^*}{\partial t} + \alpha r\left(g'\frac{1}{n} - g\right)\frac{\partial n^*}{\partial t}\right) > 0, \tag{33}$$

where the first two terms are the direct, positive effect of an increase in the corporate tax, whereas the second set of terms are the indirect, competitive effect on prices and capital costs due to changes in market entry. We know from Proposition 3 and 4 that a higher corporate tax reduces market entry $\left(\partial n^*/\partial t < 0\right)$, but increases equilibrium prices $\left(\partial p^*/\partial t > 0\right)$. From (33), it is then evident that corporate tax revenue is always increasing in the corporate tax rate when technology is CRS or IRS. However, if technology is DRS, fewer firms in the market means higher capital costs, which in turn increases capital cost deductions. Notice that this effect vanish under CBIT since $\alpha = 0$. This effect is a

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[15]Notice that equilibrium tax income is always strictly positive as long as firms' equilibrium (before-tax) profits are positive, which is ensured by the the equilibrium condition τ_2, as reported in Lemma 1.

second-order effect, and we can show that it never offsets the positive effect of an increase in the corporate tax on total corporate tax income.[16]

What is the effect of tax deductions on tax income? Differentiating (32) with respect to α we get

$$\frac{\partial T^*}{\partial \alpha} = -trgn^* + t\left(\frac{\partial p^*}{\partial \alpha} + \alpha r\left(g'\frac{1}{n} - g\right)\frac{\partial n^*}{\partial \alpha}\right) < 0. \tag{34}$$

The first term reflects the direct, negative effect of allowing for deductions for capital costs. The second set of terms are the indirect effects on prices and capital costs due to changes in market entry. We know from Proposition 4 that more tax deductions induces lower equilibrium prices ($\partial p^*/\partial \alpha < 0$). This effect reinforces the negative, direct effect. The effect on market entry depends on technology. From Proposition 3, we know that under CRS, tax deductions have no impact on market entry ($\partial n^*/\partial t = 0$). In this case ACE will always generate lower tax income than CBIT. If technology is IRS ($g' < ng$), then tax deductions triggers market entry ($\partial n^*/\partial \alpha > 0$), whereas the opposite ($\partial n^*/\partial \alpha < 0$) is true when technology is DRS ($g' > ng$). This implies that the last term in (34) is negative, which means that the competition effect always reinforces the direct, negative effect of tax deductions on total corporate tax income. Based on (33) and (34), we can make the following conclusion:

Lemma 2 *In a Salop model with free entry and tax revenue neutrality, tax deductions for capital costs lead to lower corporate tax income, and implies a higher corporate tax under ACE than CBIT.*

We now proceed with analyzing the welfare properties of ACE and CBIT under tax income neutrality. This analysis is quite demanding since it involves comparing welfare levels conditional on tax income being identical in the two schemes. Using (26), welfare under CBIT ($\alpha = 0$) and ACE ($\alpha = 1$) are given by

$$W_c^{sb} = m + v - \frac{\tau}{2n_c^*} - p_c^*(1 - t_c),$$

and

$$W_a^{sb} = m + v - \frac{\tau}{2n_a^*} - p_a^*(1 - t_a) - t_a r g_a n_a^*,$$

where subscript a and c denote ACE and CBIT, respectively. Based on this, we can write the welfare difference as follows

$$\Delta W := W_c^{sb} - W_a^{sb} = \frac{\tau}{2}\left(\frac{1}{n_a^*} - \frac{1}{n_c^*}\right) + p_a^*(1 - t_a) - p_c^*(1 - t_c) + t_a r g_a n_a^*,$$

where $\Delta W > (<)\, 0$ implies that CBIT (ACE) is socially desirable. We see that CBIT is

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[16]See proof of Lemma 2 in the Appendix.

welfare improving unless ACE involves stronger competitive effects (more entry and lower prices) simply because CBIT generates higher tax income by disallowing tax deductions for capital costs. From Proposition 3, we know that ACE (CBIT) induces more entry than CBIT (ACE) when technology is IRS (DRS), whereas with CRS technology entry is unaffected by tax deductions. Moreover, from Proposition 4, we know that ACE leads to lower prices than CBIT. These results are derived assuming a constant corporate tax rate. However, assuming tax income neutrality, the pro-competitive effects of ACE may be offset by the higher corporate tax rate ($t_a > t_c$). Thus, the scope for CBIT to be welfare improving increases under tax income neutrality due to the adverse effects of corporate taxation on entry and pricing.

To illustrate the welfare properties of ACE and CBIT under tax income neutrality, we construct numerical examples assuming the (inverse) production function relating capital and output is given by $k = g(y) = y^\theta$. Below, we report two tables where we vary the tax rate under CBIT from a low tax level ($t_c = 0.1$) to a high tax level ($t_c = 0.5$), and compute the corresponding tax rate under ACE that generates the same tax income level as with CBIT.

Table 1. Numerical results under tax income neutrality with low tax rate.

	CRS ($\theta = 1$)		DRS ($\theta = 2$)		IRS ($\theta = 0.5$)	
	CBIT	ACE	CBIT	ACE	CBIT	ACE
Tax rate	0.100	0.159	0.100	0.106	0.100	0.265
Entry	13	12	13	13	8	7
Price	0.265	0.267	0.171	0.169	0.407	0.418
Tax income	0.027	0.027	0.017	0.017	0.041	0.041
Welfare	3.685	3.677	3.769	3.771	3.509	3.480

Parameter values: $\tau = 2; r = 0.1; m = v = 2; f = 0.01$.

Table 2. Numerical results under tax income neutrality with high tax rate.

| | CRS ($\theta = 1$) | | DRS ($\theta = 2$) | | IRS ($\theta = 0.5$) | |
	CBIT	ACE	CBIT	ACE	CBIT	ACE
Tax rate	0.500	0.700	0.500	0.514	0.500	0.780
Entry	10	7	10	9	5	4
Price	0.400	0.386	0.240	0.244	0.624	0.600
Tax income	0.200	0.200	0.120	0.120	0.312	0.312
Welfare	3.700	3.671	3.780	3.764	3.488	3.462

Parameter values: $\tau = 2; r = 0.1; m = v = 2; f = 0.01$.

For the low tax rate case in Table 1, we see that CBIT yields higher welfare than ACE in case of CRS and IRS technology, whereas ACE yields higher welfare in case of DRS. This is somewhat surprising since the pro-competitive effects of ACE are stronger under IRS (cf. Proposition 3). However, the reason is that tax income neutrality requires a large increase in the corporate tax rate under ACE when technology is IRS, and this has adverse effects on entry and prices. Actually, it is only in the DRS case that prices are lower and entry is at the same level under ACE. In this case, tax income neutrality only requires a small increase in the corporate tax under ACE. In the case of CRS and IRS, entry is higher, prices are lower and welfare is higher with CBIT.

For the high tax rate case in Table 2, we see that ACE is never welfare improving. The reason is partly that first-best is achieved under CBIT with a corporate tax rate equal to one half, and partly that tax income neutrality leads to a corporate tax rate under ACE above 1/2, which induces suboptimal entry. From Table 2, we also see that entry is always higher under CBIT, whilst prices are lower under ACE and CRS/IRS technology. These numerical examples illustrate that the welfare ranking of ACE and CBIT is generally ambiguous, but that tax income neutrality is likely to make CBIT preferable to ACE due to the adverse effects of corporate taxation on entry and prices.

6 Concluding remarks

This paper studies how the Corporate Business Income Tax (CBIT) and the Allowance for Corporate Equity tax (ACE) perform under imperfect competition. When firms have market power consumer surplus is positively affected by tougher competition whereas profit and tax revenue may fall when competition intensifies. We show in this paper that the corporate tax plays a role in balancing gains to consumers against the costs of competition, since a positive corporate tax reduces excessive market entry and wasteful

use of resources. The welfare comparison between these two tax systems is ambiguous and depends on assumptions about production technology, entry and the level of the corporate tax rate. We show that CBIT may be the preferred choice if the economy to a large extent is characterized by imperfect-competition between multinational firms. The reason is that under IRS, capital cost tax deductions increases firms' profits, whereas the strategic effect via price competition does not matter much. In support of this result is a large literature suggesting that multinationals produce under IRS technology.[17] In general, it is unclear how important multinationals are in the economy and if there is a tipping point. Thus, we cannot conclude in favor of CBIT or ACE.

Appendix: Proofs of Lemmata and Propositions

Proof of Lemma 1. The second-order condition

$$\frac{\partial^2 \pi_i}{\partial p_i^2} = -\frac{1}{\tau} \left[2(1-t) + r(1-\alpha t) g'' \frac{1}{\tau} \right] < 0$$

is always fulfilled if $g'' \geq 0$. However, if $g'' < 0$, then we need $2(1-t) + r(1-\alpha t) g'' \frac{1}{\tau} > 0$, which is always true if $\tau > \tau_1$ defined in (9). In addition, for the price equilibrium in (7) to exist, we need to ensure that the equilibrium profits in (8) is non-negative for any $n \geq 2$. Since equilibrium profits are monotonically increasing in τ, i.e., $\partial \pi^* / \partial \tau = (1-t)/n^2 > 0$, we can set $\pi^* = 0$ and solve for τ, which yields the lower bound τ_2 defined in (10). Thus, for any $\tau > \tau_2$, equilibrium profits is strictly positive. QED.

Proof of Proposition 2. (i) From (13), we see that $\partial \pi^* / \partial t < 0$ is always true if $\alpha = 0$ or $g' \geq ng$. On the other hand, if $\alpha > 0$ and $g' < ng$, then $\partial \pi^* / \partial t < 0$ is true if and only if $\tau > n^2 \alpha r \left(g - g' \frac{1}{n} \right)$. Comparing this with the non-negative profit condition in (10), it is easily verified that

$$\tau_2 := \frac{n^2}{1-t} \left(\alpha r \left(g - g' \frac{1}{n} \right) + f \right) > n^2 \alpha r \left(g - g' \frac{1}{n} \right) \quad \text{for all valid parameter values.}$$

Thus, it follows that $\partial \pi^* / \partial t < 0$ is always true. (ii) From (14), it follows that

$$\frac{\partial \pi_i^*}{\partial \alpha} \begin{cases} > 0 & if \quad g' < ng \\ = 0 & if \quad g' = ng \\ < 0 & if \quad g' > ng \end{cases}.$$

QED.

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[17]Theoretical contributions in support of IRS technology can be found in Helpman (1984) and Ethier (1986), whereas Carr et al. (2001) and Antweiler and Trefler (2002) are examples of a vast empirical literature. Antweiler and Trefler (2002) estimate that one third of all goods-producing industries are characterized by IRS technology.

Proof of Proposition 3. (i) The second-order condition in (9) ensures that the denominator of (16) is strictly positive, and the non-negative profit constraint (10) ensures that the numerator of (16) is strictly positive. Thus, $\partial n^*/\partial t < 0$ is always true. (ii) The second-order condition in (9) ensures that the denominator of (17) is strictly positive. Thus, the sign of (17) is determined by the sign of the numerator, which implies that

$$\frac{\partial n^*}{\partial \alpha} \begin{cases} > 0 & if \quad g' < n^*g \\ = 0 & if \quad g' = n^*g \\ < 0 & if \quad g' > n^*g \end{cases}.$$

QED.

Proof of Proposition 4. (i) Using the second-order condition in (9) and that $\partial n^*/\partial t < 0$ from Proposition 3, it follows from (18) that $\partial p^*/\partial t > 0$ is always true. (ii) If $\partial n^*/\partial \alpha \geq 0$, which is the case when $g' \geq n^*g$ (cf. Proposition 3), it follows from (19) that $\partial p^*/\partial \alpha < 0$ is always true by the second-order condition in (9). However, if $\partial n^*/\partial \alpha < 0$, which is the case if $g' > n^*g$ (cf. Proposition 3), then $\partial p^*/\partial \alpha$ is potentially ambiguous. Inserting (17) into (19), and simplifying the expression, we get

$$\frac{\partial p^*}{\partial \alpha} = -rt\frac{\tau\left(1-t\right)\left(g'+ng\right)+gnrg''\left(1-t\alpha\right)}{\left(1-t\right)\left(2\tau\left(1-t\right)+rg''\left(1-t\alpha\right)\right)}.$$

It is straightforward to show that both the numerator and denominator are strictly positive using the equilibrium conditions in Lemma 1. Thus $\partial p^*/\partial \alpha < 0$ is always true irrespective of technology. QED.

Proof of Proposition 5. (i) Observe from (28) that $t^* > 0$ is always true if $g' \geq ng$. However, if $g' < ng$, then $t^* > 0$ holds if only if $\tau >$. However, using the non-negative profit condition in (10), it is easily verified that $\tau_2 > nr\alpha\left(ng - g'\right)$, which ensures that $t^* > 0$ is true for all valid parameter values. Inserting (28) the zero-profit condition (15), we get

$$\frac{\tau}{2\left(n^*\right)^2} + r\left(g'\frac{1}{n^*} - g\right) - f = 0,$$

which exactly coincide with the condition for the first-best number of firms in (25).

(ii) Since $\partial n^*/\partial t < 0$ from (16), it follows that $n^* < (>) n^{fb}$ when $t > (<) t^*$.

(iii) It follows from (28) that $t^* = 1/2$ if technology is CRS ($g' = ng$) and/or a CBIT scheme ($\alpha = 0$) is in place.

(iv) It follows from (28) that $t^* > 1/2$ with tax deductions ($\alpha > 0$) and IRS technology ($g' > ng$), whereas the opposite is true with a DRS technology ($g' < ng$).

Proof of Proposition 6. (i) With a CRS technology ($g' = ng$), then (29) holds for any $\alpha \in [0, 1]$.

(ii) With a IRS technology $(g' < ng)$, from (31), we get

$$\alpha^* = \begin{cases} 0 & if \quad t \leq \frac{1}{2} \\ (0,1) & if \quad t \in \left(\frac{1}{2}, \widetilde{t}\right) \\ 1 & if \quad t \geq \widetilde{t} \end{cases}, \quad \text{where } \widetilde{t} > \frac{1}{2}.$$

(iii) With a DRS technology $(g' > ng)$, then from (31), we get

$$\alpha^* = \begin{cases} 1 & if \quad t \leq \widetilde{t} \\ (0,1) & if \quad t \in \left(\widetilde{t}, \frac{1}{2}\right) \\ 0 & if \quad t > \frac{1}{2} \end{cases}, \quad \text{where } \widetilde{t} < \frac{1}{2}.$$

Proof of Lemma 2.

(i) Inserting the equilibrium price (7) into equation (23), we get

$$T = t\left(\frac{\tau}{n} + r\left(g'\frac{1-\alpha t}{1-t} - \alpha gn\right)\right).$$

Differentiating this expression with respect to t and collecting terms yields equation (33). We have that $\partial n^*/\partial t < 0$ from Proposition 3 and $\partial p^*/\partial t > 0$ from Proposition 4. This implies $\partial T^*/\partial t > 0$, as given by (33), is always true when technology is CRS $(g' = ng)$ or IRS $(g' < ng)$. If technology is DRS $(g' > ng)$, then still

$$\frac{\partial T^*}{\partial t} = \frac{\tau}{n} + rg'\frac{1-2\alpha t + \alpha t^2}{(1-t)^2} - t\left(\frac{\tau}{n^2} + rg''\frac{1-\alpha t}{1-t}\frac{1}{n^2} - \alpha r\left(g'\frac{1}{n} - g\right)\right)\frac{\partial n^*}{\partial t} > 0.$$

(ii) We have that $\partial p^*/\partial \alpha < 0$ from Proposition 4 and that

$$\frac{\partial n^*}{\partial \alpha} \begin{cases} > 0 & if \quad g' < n^*g \\ = 0 & if \quad g' = n^*g \\ < 0 & if \quad g' > n^*g \end{cases},$$

from Proposition 3. From this, it follows that

$$\frac{\partial T^*}{\partial \alpha} = -trgn^* + t\left(\frac{\partial p^*}{\partial \alpha} + \alpha r\left(g'\frac{1}{n} - g\right)\frac{\partial n^*}{\partial \alpha}\right) < 0$$

must be true. QED.

References

Antweiler, W., and D. Trefler, 2002. Increasing Returns and All That: A View from Trade. The American Economic Review 92, 93–119.

Boadway, R., and N. Bruce, 1984. A General Proposition on the Design of a Neutral Business Tax. Journal of Public Economics 24, 231–239.

Carr, D.L., J.R. Markusen, and K.E. Maskus, 2001. Estimating the Knowledge-Capital Model of the Multinational Enterprise. American Economic Review 91, 693–708.

De Mooij, R.A, and M. Devereux, 2011. An Applied Analysis of ACE and CBIT Reforms in the EU. International Tax and Public Finance 18, 93–120.

Diamond, P., and J.A. Mirrlees, 1971. Optimal Taxation and Public Production I: Production efficiency. American Economic Review 61, 8–27.

Dixit, A.K., and J.E. Stiglitz, 1977. Monopolistic Competition and Optimum Product Diversity. American Economic Review 67, 297–308.

Ethier, W.J., 1986. The Multinational Firm. Quarterly Journal of Economics 101, 805–834.

Institute for Fiscal Studies, 1991. Equity for Companies. A Corporation Tax for the 1990s. London.

Gordon, R., 1986. Taxation of Investment and Savings in a World Economy. American Economic Review 75, 1086–1102.

Gu, Y., Wenzel, T., 2009. A Note on the Excess Entry Theorem in Spatial Models with Elastic Demand. International Journal of Industrial Organization 27, 567-571.

Helpman, E., 1984. A Simple Theory of International Trade with Multinational Corporations. Journal of Political Economy 92, 451–471.

Keuschnigg, C., and E. Ribi, 2013. Profit Taxes and Financing Constraints. International Tax and Public Finance 20, 808–826.

Köthenbürger, M., and M. Stimmelmayr, 2014. Corporate Deductibility Provisions and Managerial Incentives. Journal of Public Economics 111, 120–130.

Matsumura, T., Okamura, M., 2006. A Note on the Excess Entry Theorem in Spatial Markets. International Journal of Industrial Organization 24, 1071-1076.

Mirrlees, J.A., S. Adam, T.J. Besley, R. Blundell, S. Bond, R. Chote, M. Gammie, P. Johnson, G.D. Myles, and J.M. Poterba, 2011. Tax by Design: The Mirrlees Review. Oxford University Press, Oxford.

Myers, S.C., 1977. The Determinants of Corporate Borrowing. Journal of Financial Economics 5, 147–175.

Radulescu, D., and M. Stimmelmayr, 2007. ACE vs.CBIT: Which Is Better for Investment and Welfare? CESifo Economic Studies, 294–328.

Salop, S., 1979. Monopolistic Competition with Outside Goods. Bell Journal of Economics 10, 141–156.

SOU2014:40, 2014. Neutral Bolagsskatt – För Ökad Effektivitet och Stabilitet. Slutbetänkande av Företagsskattekommittén. Stockholm.

US Department of Treasury, 1992. Integration of the Individual and Corporate Tax Systems: Taxing Business Income Once. US Government Printing Office, Washington.

Vickrey, W.S., 1964. Microstatics. Harcourt, Brace and World, New York.