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Profit taxes and financing constraints

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Abstract Without financing frictions, profit taxes reduce investment by their effect on the user cost of capital. With financing constraints, investment becomes sensitive to cash-flow. In this situation, even small taxes impose first order welfare losses, and ACE and cash-flow tax systems are no longer neutral. When banks become active and provide monitoring services in addition to finance, an ACE tax yields larger investment and welfare than an equal yield cash-flow tax.

Keywords Financing constraints · Cash-flow tax · ACE tax

JEL Classification G38 · H25

1 Introduction

When discussing the effects of profit taxation, the tax reform literature often relies on models with full information, where firms have unimpeded access to external capital.

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Accordingly, investment is expanded until the marginal return is equal to the user cost of capital. Taxes affect investment only by their impact on the user cost (cf. Jorgenson 1963, and Auerbach 2002, for a recent review). The corporate finance literature, however, provides substantial evidence that the relationship between firms and outside investors is subject to information problems that tend to limit the amount of external funds. Hence, firms with profitable investment opportunities are often subject to financing constraints, which prevent them from investing the desired, first best amount of capital (see, among others, Hubbard 1998; Tirole 2001, 2006; Beck et al. 2005; Beck and Demirgüc-Kunt 2006; Aghion et al. 2007).

This paper studies how profit taxes may affect investment and welfare in the presence of financial constraints. In particular, we show how the effects of taxes change when banks become more active and provide monitoring services in addition to external funds. The analysis rests on corporate finance theory as in Holmstrom and Tirole (1997) and Tirole (2006) which explains credit constraints by entrepreneurial moral hazard. The capacity to raise credit depends on the amount of pledgeable income available for repayment to banks. Investment becomes sensitive to cash-flow and own assets. Relating to the main predictions of this paper, Kaplan and Zingales (1997, p. 174) state that "… in an imperfect capital market world, investments are sensitive to internal funds; while in a perfect capital market world, they are not". Empirical studies measuring cash-flow sensitivity find that investment expands by a factor of 1.2–1.3 per dollar of cash-flow (cf. Fazzari and Petersen 1993; Calomiris and Hubbard 1995; Carpenter and Petersen 2002).

Financing constraints are relevant for small and medium sized firms but often also for larger ones. Schaller (1993) and Chirinko and Schaller (1995) find correlations between equipment investment and internal funds around 0.4 for small firms, which are higher than the corresponding values of around 0.2 for large firms. Young innovative firms are more likely to become credit-rationed. R&D intensive firms typically have large investment opportunities compared to own funds, are more dependent on entrepreneurial inputs and, for this reason, are more difficult to monitor. Guiso (1998) shows that innovative firms are more likely to be constrained, which makes them unable to fully exploit their growth potential. The correlation between investment and own cash-flow is also significantly higher for R&D intensive investments (Brown and Petersen 2009).

Apart from firm's size, R&D intensity and productivity, constrained and unconstrained firms also differ in their banking relationship (cf. Petersen and Rajan 1994; Degryse and Ongena 2005). When firms have close ties to banks, the informational asymmetry is reduced, and they are more likely to obtain the required funding. Hoshi et al. (1990) indeed report investment–cash-flow sensitivities of only around 0.05 for these firms in Japan, whereas correlations for independent firms vary between 0.45 and 0.5. Similar numbers are found by Schaller (1993) and Chirinko and Schaller (1995). Gorton and Schmid (2000) find that firm performance improves with bank equity holdings and stress a monitoring and advising role of banks. Investigating a sample of Japanese firms, Fukuda and Hirota (1996) document that a close relationship to the main bank reduces agency costs and allows firms to raise more debt. Apart from raising firms' debt capacity, active intermediaries, such as venture capitalists and relationship banks, may also add value to firms by increasing their survival chances and helping them to grow larger.[1] Based on this evidence, we conclude that financing constraints may be relevant arguably for the most innovative parts of the business sector, can significantly affect a country's performance, and can partly be relaxed by a more active role of banks.

How taxes affect investment of constrained firms differs from standard theory where investment exclusively depends on the user cost of capital. This paper derives three results. We first show that taxes, by eroding cash-flow and pledgeable income, tighten financing constraints and reduce investment, independently of their effect on the user cost. Even small tax rates impose first order welfare losses when firms are constrained. These firms are unable to fully exploit investment opportunities and, thus, earn an above normal, excess return on marginal investment. The welfare loss is proportional to the excess return. Our second result demonstrates that neither a CF (cash-flow) nor an ACE (allowance for corporate equity) tax system is neutral when firms are constrained. CF and ACE taxes feature prominently in the tax reform debate.[2] According to standard theory, these two tax systems are neutral with respect to the scale of investment, and equivalent when both are required to raise the same present value of tax revenue (see Sandmo 1979; Boadway and Bruce 1984, for models under certainty; and Bond and Devereux 1995, 2003, under uncertainty). In taxing rents, however, they reduce firms' pledgeable income and the scale of investment. Slightly less obvious, we still find the two tax systems to be equivalent.

In generalizing the result on the equivalence of CF and ACE taxes to the case of constrained firms, we have assumed that banks are competitive and are not engaged in active oversight of firms (cf. Diamond 1984), as the literature on relationship banking and venture capital documents. The quality of monitoring services might be considered an important aspect of financial development. Our third and most important result shows that the equivalence between ACE and CF taxes breaks down when banks are active in monitoring and control of financially dependent firms. The ACE tax reduces investment and welfare less than an equal yield CF tax. Active intermediaries may directly add value by advising firms. The non-contractibility of monitoring and advising leads to double moral hazard where not only managerial effort but also the banks' advising must be incentivized. The timing of tax liabilities becomes important. While the CF tax provides tax relief upfront, the ACE tax gives relief at the late return stage, thereby providing better incentives, and leads to higher success probabilities, scale of investment and welfare.[3]

Early empirical literature in public economics already emphasized the important role of internal funds and the different effects of taxes on investment in the presence

[1] This is a frequent finding in the venture capital literature; see, e.g., Hellmann and Puri (2002).

[2] The CF tax was recommended by Meade (1978) and the US President's Advisory Panel (2006). The ACE system was proposed by the Capital Taxes Group of the Institute for Fiscal Studies (1991) and is adopted in the Mirrlees Review (Mirrlees et al. 2011, and background studies in Mirrlees et al. 2010).

[3] In a Separate Appendix (available on www.alexandria.unisg.ch/publications/54285), we consider an alternative model with heterogeneous firms where monitoring of constrained firms does not directly add value and raise the success probability. It rather exercises active oversight and control, thereby raising pledgeable income and improving a firm's access to external financing. Again, an ACE tax yields larger investment and welfare than an equal-yield CF tax. Although the result is qualitatively the same, the mechanism is different. Compared to a CF tax, the ACE system redistributes from unconstrained firms where capital earns a normal return, towards constrained firms where capital earns an excess return.

of financing constraints (Fazzari et al. 1988a, 1988b; Hubbard 1998). One strand of the theoretical literature is based on moral hazard; see Hagen and Sannarnes (2007) and Keuschnigg and Nielsen (2004) and references therein.[4] Hagen and Sannarnes (2007) also show that an ACE tax is not neutral and leads to underinvestment in effort, but do not discuss the CF tax. The key difference is that these authors assume that effort translates into variable success probabilities while the scale of investment is fixed. Our model endogenizes the scale of investment and provides a clear link to standard user cost theory as it applies in the absence of financing frictions. Another strand of the literature assumes a different type of agency problems along the lines of Jensen (1986) where self-serving, empire building managers divert free cash-flow to internal investments with a lower rate of return, compared to investment opportunities outside the firm (see Chetty and Saez 2010, and, in the same vein, Köthenbürger and Stimmelmayr 2009). Clearly, this approach is complementary to our analysis and relates to mature firms which are not constrained in outside funding but rather face the opposite problem of having 'free cash-flow' that might be inefficiently invested internally rather than being distributed to shareholders. None of these papers provides a comparison of CF and ACE taxes and discusses their potential non-equivalence.

The paper proceeds as follows. Section 2 sets up the basic model and compares equal yield CF and ACE taxes. Section 3 considers active intermediation and shows that an ACE tax facilitates constrained investment and gives higher welfare relative to an equal yield CF tax. Section 4 concludes. The Appendix documents some technical calculations.

2 The basic model

2.1 Full information benchmark

The analysis is based on a model with risk-neutral entrepreneurs. Investment I is successful with probability p. In this case, the firm's end-of-period value is $I + f(I)$ where $f'(I) > 0 > f''(I)$. If the firm fails, the end-of-period value is zero. If a unit of capital were invested in the deposit market, it would yield a safe rate of return r and lead to an end-of-period value $R \equiv 1 + r$.[5] Given an opportunity cost IR, the net value is $\pi = p(I + f) - IR$.[6] An investment with a safe return r is equivalent to a risky investment with a return i only in the good state if the zero profit condition $p(1+i) = R$ is satisfied. Using this, expected value is $\pi = p(f - iI)$. In the absence of tax and financial frictions, value maximizing investment is given by $f'(I) = i$.

Suppose that the firm is endowed with own assets or inside equity A. If spending exceeds own funds, the firm must borrow D from external sources. We assume that

[4] Part of the literature introduces monitoring costs in reduced form which depend on total assets and external debt; see Kanniainen and Södersten (1994), for example.

[5] The paper aims to compare the effects of ACE and CF taxes. To keep this focus, we assume the deposit rate to be exogenous and thereby exclude general equilibrium feedback effects of tax reform.

[6] In the following, we will write f and suppress the argument I when convenient.

external borrowing is done in the form of debt, new equity being excluded.[7] In introducing taxes, we focus on two polar cases, the CF (cash-flow) and ACE (allowance for corporate equity) taxes. The CF tax denies any deduction of interest expenses. Instead, it permits immediate tax depreciation of investment outlays I and thereby reduces the tax liability by τI at the beginning of period where τ is the proportional profit tax rate. Private investment outlays are, thus, reduced to $(1-\tau)I$. The firm must pay back when capital is disinvested, thus raising tax liability by τI at the end of period if the firm survives. The expected net value of the tax credit is $\tau IR - \tau pI = \tau piI$ since the risky and safe interest are related by $p(1+i) = R$. The ACE tax, in contrast, permits the deduction of interest costs $i(D+A)$ on both debt and equity but does not allow for any upfront deduction of investment outlays. To define the tax base under both systems, we denote by s the share of investment outlays eligible for immediate tax deductions, and by λ the share of deductible interest costs. Setting $s = 1$ and $\lambda = 0$ yields a CF tax and $s = 0$ and $\lambda = 1$ an ACE tax. Private investment spending is financed with debt and equity, $(1-\tau s)I = D + A$. The expected fiscal revenue G thus amounts to

$$G = pT - \tau sIR, \quad T = \tau\big[f - \lambda i(D+A) + sI\big]. \tag{1}$$

At the end of period, the firm pays tax only if it is successful, giving expected revenue pT. Unlike real world tax systems, ACE and CF taxes treat debt and equity in a perfectly symmetric way so that they are perfect substitutes in our model. Replacing R and $D + A$, we also find that the two systems, at a given level of investment and earnings, generate the same total value of expected revenue, $G^{\text{ACE}} = p\tau(f - iI) = G^{\text{CF}}$. The key difference is that the CF tax concentrates tax liability at the end of period but grants a tax rebate at the beginning of period. The ACE tax, in contrast, is front loaded. Tax is high at the beginning (no tax rebate) while it is kept low at the end of period when earnings accrue: $T^{\text{ACE}} = \tau(f - iI) < T^{\text{CF}} = \tau(f + I)$.[8]

Given the tax system in (1), net firm value π is divided between the entrepreneur, π^e, and the bank, π^b, as follows:

$$\begin{aligned} \pi^e &= p\big(I + f - (1+i)D - T\big) - AR, \\ \pi^b &= p(1+i)D - DR, \\ \pi &= p(I + f - T) - (1-\tau s)IR. \end{aligned} \tag{2}$$

[7] Our simple two-state model cannot distinguish between debt and *new* outside equity (see Tirole 2006), but this is also not the focus of our analysis. Ellingsen and Kristiansen (2011) offer an interesting but more complicated approach that introduces debt as well as outside equity.

[8] Note finally that a pure CF tax permits negative tax payments. Suppose own funds stem from previous profits A_0 minus tax, $A = (1-\tau)A_0$. The financing identity $D = (1-\tau)(I - A_0)$ shows that a financially dependent firm gets a tax rebate, i.e. $\tau(A_0 - I) < 0$. The net value of tax liability is $G = \tau p(f + I) + \tau(A_0 - I)R$. Allowing tax losses to be carried forward changes the end of period tax liability in the good state to $G = \tau p[f - iI + (1+i)A_0]$. Apart from the tax related to historical profit A_0, the carry forward of tax losses essentially converts the CF tax into an ACE tax. If neither a tax refund nor a carry forward of tax losses were possible, the CF would no longer be neutral in the unconstrained case, and would be more distorting in a constrained equilibrium.

The opportunity cost of equity is AR. The bank incurs refinancing costs on the deposit market equal to R per unit of lending. Without financial frictions, competitive banks can lend any amount subject to the break even condition $\pi^b = 0$, or $p(1+i) = R$. The borrowing rate i must exceed the deposit rate r by an intermediation margin that reflects the rate of default. The owner is entitled to the cash-flow after taxes and debts have been paid. With banks making zero profit, and noting $(1-\tau s)I = A + D$, the entrepreneur's expected surplus is equal to the total surplus, $\pi^e = \pi = p[(1-\tau)f - (1-\tau\lambda)(1-\tau s)iI]$. Value maximization leads to

$$f'(I) = \frac{(1-\tau\lambda)(1-\tau s)}{1-\tau} \cdot i \equiv u(\tau). \tag{3}$$

The firm invests until the return on capital equals the user cost. Both possibilities of tax deduction reduce the user cost of capital u. The full information case replicates the neutrality result of Bond and Devereux (2003) for CF and ACE taxes, defined by $s = 1$, $\lambda = 0$ and $s = 0$, $\lambda = 1$, respectively. In the absence of market imperfections, both systems yield $f' = i$ in (3) and lead to efficient investment. Since CF and ACE taxes also yield the same level of net revenue $G = p\tau(f - iI)$, they are fully equivalent.

CF and ACE taxes are known to be neutral in the standard model both in situations of certainty and uncertainty (Boadway and Bruce 1984; Bond and Devereux 2003). One question is whether the ACE system should allow the deduction of the cost of finance at the safe or at the higher risky interest rate. Bond and Devereux (1995, Eq. (6)) argue that an ACE tax must allow for the opportunity cost of finance, evaluated at the *safe rate of interest* r when *full loss-offset* is granted. Under these conditions, the period 1 tax liability with ACE would be $T = \tau pf - \tau rI + \tau[p(I-I) - (1-p)I]$. The square bracket lists the tax consequences of selling the asset. In the absence of depreciation, book value equals market value, leaving a zero capital gain in case of success and a capital loss of $-I$ when the firm fails. With full loss-offset, the firm must get a tax refund of $-\tau rI$ from interest expenses, and of $-\tau I$ from full loss-offset when the market value falls to zero. Rearranging yields $T = \tau[p(I+f) - RI] = \tau p(f - iI)$ which corresponds to (1). The present analysis assumes deduction of financing costs at the *risky loan rate* i *without loss-offset*. By (1), the firm owes $\tau(f - iI)$ if successful but receives no tax refund when it fails. The expected tax liability is the same under both assumptions. The two alternatives are equivalent.

2.2 Finance constrained investment

A standard way of rationalizing financing constraints is to introduce a moral hazard problem which creates conflicting interests of outside investors and the managing owner. It is assumed that the success probability of the firm depends on discrete managerial effort. When the entrepreneur exerts effort, she generates a high success probability p, but must forego private benefits. Alternatively, she can spend only reduced effort and, instead, consume private benefits $B > 0$, leading to a low success rate

$p_L < p$. We assume that these benefits increase linearly with investment, $B = bI$.[9] It is assumed that effort is not verifiable and not contractible and must thus be induced by financial incentives. The timing is: (i) government policy; (ii) external borrowing and investment; (iii) managerial effort; (iv) outcomes and payments depending on success or failure.

Given moral hazard, owner-managers must keep a sufficient profit stake to assure incentives which limits external financing. The entrepreneur chooses effort after a financing contract has been secured, i.e., debt and interest are already given at this stage. To highlight the reward for effort, we rewrite the surplus in (2) as $\pi^e = pv^e - AR$, where

$$v^e \equiv I + f - T - (1+i)D = (1-\tau)(f - uI) + (1+i)A. \tag{4}$$

The entrepreneur prefers high effort as long as the contract is incentive compatible:[10]

$$pv^e \ge p_L v^e + bI \quad \Leftrightarrow \quad v^e \ge \beta I, \quad \beta \equiv b/(p - p_L). \tag{5}$$

To elicit high effort, outside investors must cede a large enough stake to the managing owner. Given that the entrepreneur must earn at least βI, the bank can demand at most $(1+i)D \le I + f - T - \beta I$, see (4). The right-hand side is pledgeable income which is the maximum incentive compatible repayment that a firm can offer.

Assumption 1 At the unrestricted investment level, given by $f'(I^{\mathrm{FB}}) = u$, the incentive compatibility condition is violated, i.e., $(1-\tau)[f(I^{\mathrm{FB}}) - uI^{\mathrm{FB}}] + (1+i)A < \beta I^{\mathrm{FB}}$.

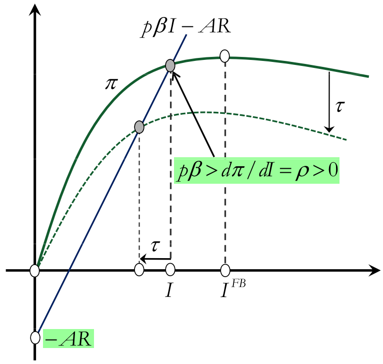
In principle, the firm's own equity A could be so large that the incentive constraint is slack at the optimal investment level in (3). The solution would be the same as in the preceding section. If own funds are rather small and optimal investment I^{FB} requires high debt, the entrepreneur's residual income becomes so small that high effort is not rewarded anymore. In this case, the entrepreneur would prefer low effort and the success probability would fall to p_L, possibly close to zero, giving an inferior outcome.[11] To avoid this, investment and bank lending must be restricted until the

[9]Linearity is for convenience only. The typical assumption would be convex increasing effort costs, here private benefits. Since the return on investment is concave by $f(I)$, convexity is not needed.

[10]Ellul et al. (2010) offer an alternative and largely equivalent formulation of credit constraints where the owner may divert part of output for private use. Owners must then keep a minimum income to prevent diversion of resources (instead of preventing low effort) which reduces pledgeable income and limits outside funding.

[11]In spite of private benefits, investment is not distorted when the financing constraint is slack. To show this, we abstract from tax and denote by $\pi_H^* = \max_I p(f(I) - iI)$ the surplus with high effort when no private benefits are enjoyed. First best investment I_H is given by $f'(I_H) = i$. With low effort, the surplus is $\pi_L^* = \max_I p_L(f(I) - i_L I) + bI$. The risky loan rate is high, $i_L > i$, when the success probability is low, $p_L(1 + i_L) = R$. Investment is distorted, $f'(I_L) = i_L - b/p_L$. We assume $\pi_H(I) > \pi_L(I)$ for any $I \in [0, \max\{I_H, I_L\}]$, i.e., high effort is preferred for *any* investment level in this range. The optimum is, thus, π_H^* and I_H. When the incentive constraint is slack and high effort is anticipated, private benefits are not consumed, leading to undistorted investment. When the constraint binds, it restricts external lending and investment to $I_c < I_H$ so that high effort remains assured. The surplus is reduced but still exceeds the maximized surplus with low effort, $\pi_H^* > \pi_H(I_c) > \pi_L^*$.

Fig. 1 Constrained investment



required credit repayment does not exceed pledgeable income. The incentive compatibility condition (5) is binding and implicitly determines investment. Multiplying by p and using (4) as well as $\pi^e = \pi$ with zero profit in banking shows that the incentive constraint is equivalent to

$$\pi = p(1-\tau)\big(f(I) - uI\big) = p\beta I - AR. \tag{6}$$

Proposition 1 *With a binding financing constraint, investment is not driven by the user cost of capital but depends, instead, on pledgeable income and own assets. Constrained firms earn an excess return on investment* $\rho \equiv (1-\tau)p(f'(I) - u)$ *such that* $p\beta > \rho > 0$.

By the definition of credit rationing, a firm could expand investment and earn higher profit but is denied credit, implying $d\pi^e/dI = \rho > 0$. Investment earns a return in excess of the user cost, $f' > u$. Additional credit is denied if higher investment violates the incentive constraint by raising private benefits more than residual income, $dv^e/dI = (1-\tau)(f' - u) < \beta$. Multiplying by p gives the last inequality in Proposition 1.

Figure 1 illustrates. The incentive line $p\beta I - AR$ refers to the right-hand side of (6) and gives the entrepreneur's minimum stake that makes her willing to supply high managerial effort, minus own capital committed to the firm. The concave curve π is the actual income provided by the financial contract. The incentive condition is fulfilled with investment levels that are smaller than the level determined by the intersection point. The slopes at this point reflect the inequalities noted in Proposition 1. Further expanding investment and credit would violate the incentive condition. The fact that the slope of π is positive means that a constrained firm earns an excess return ρ and is left with profitable, unexploited investment opportunities. The maximum of the π-curve yields unconstrained investment I^{FB}, given by $f'(I^{\mathrm{FB}}) = u$, which reduces the excess return to zero. This situation would occur if the incentive constraint were slack at the optimal investment scale, either because agency problems are small (small β and flat incentive line), or the firm is financially strong (high own funds A, shifting the incentive line down). Assumption 1 excludes this case.

In a constrained equilibrium, the incentive constraint is also assumed to bind after a small shock. Differentiating (6) shows how investment depends on the tax rate, own funds and private benefits:

$$dI = -\frac{p(f - uI) + p(1-\tau)Iu'}{m} \cdot d\tau + \frac{R}{m} \cdot dA - \frac{pI}{m} \cdot d\beta, \tag{7}$$

where $m \equiv p\beta - \rho > 0$. Constrained investment falls with the profit tax. However, the mechanism is entirely different from user cost theory. The tax reduces pledgeable income that is available for repayment. Consequently, less external funding can be obtained and investment must be cut, see Fig. 1.

The tightness of credit constraints may differ by firm and country characteristics as discussed in the introduction. Financing problems tend to be more frequent among younger and more innovative firms. These firms are often dependent on the entrepreneur's business idea and tend to have little own assets. They might suffer to a larger extent from entrepreneurial opportunism and potential consumption of private benefits (larger b and β) which makes it more expensive to incentivize the entrepreneur and, thus, reduces pledgeable income. In Fig. 1, low own funds A shift up the incentive line while a high value of β makes it steeper. Firms with these characteristics are more constrained and invest at a smaller scale. The model can also be used to illustrate cross-country differences in institutional and financial development. Better institutions such as tighter accounting standards or anti-director rights may be interpreted as making management more accountable which reduces private benefits, improves access to external financing and allows a larger investment scale. A similar case could be made with respect to financial sector productivity in monitoring and advising, see Sect. 3. Financial development could thereby boost firms' access to external financing and investment. Of course, none of these country and firm level characteristics (except plant productivity) play a role in standard user cost theory which applies in the absence of financial frictions.

The existence of financing constraints not only changes the impact of taxes on investment but fundamentally alters the efficiency properties. Welfare is measured by the social surplus of a firm which is the sum of private surplus plus the net value of public revenue. Adding (1) and (2) and using $p(1+i) = R$ yields the social value[12] $\pi^* = \pi + G = p(f(I) - iI)$. Raising the tax rate changes welfare by

$$\frac{d\pi^*}{d\tau} = p\big[\big(f' - u\big) + (u - i)\big]\,\frac{dI}{d\tau}. \tag{8}$$

The welfare change is proportional to the total wedge between the pre-tax return and market interest, $f' - i$. This wedge is split into a tax wedge $u - i$ and an excess return $f' - u$. The excess return arises because the financing constraint limits investment to a level where the gross return exceeds the cost of capital, $f' > u$.

Proposition 2 *A small profit tax rate imposes a first order welfare loss when investment is finance constrained.*

[12]The incentive constraint assures that no private benefits are consumed. They are thus not part of the welfare measure. In deriving (6), we have argued that an equilibrium with high effort is preferred to one with low effort and consumption of private benefits.

This result is independent of the specific form of the profit tax (conventional, ACE or CF). If the tax rate is zero, the user cost is always equal to the loan rate, $u = i$, which still leaves an excess return $f' > i$. Even a small tax reduces investment as in (7) and leads to a first order welfare loss proportional to the excess return, $d\pi^* = p(f' - i)dI$.

The question is whether ACE and CF taxes are efficient and equivalent. Both systems eliminate the tax wedge so that the user cost is equal to the lending rate, $u = i$, and independent of the tax rate. However, even if the tax is neutral with respect to the user cost, it still drains cash-flow and thereby restricts investment. Noting that $u' = 0$ in (7), the impact on investment simplifies to $dI/d\tau = -p(f - iI)/m$, where $f - iI$ is positive by concavity. Clearly, CF and ACE taxes are not neutral with respect to investment when firms are finance constrained.[13] Since the behavioral effects of both tax regimes are identical, the net value of fiscal revenue, $G = \tau p(f - iI)$, and welfare, $\pi^* = p(f - iI)$, must both change by the same amount as well. In particular, the welfare loss is again proportional to the excess return, $d\pi^* = p(f' - i)dI$.

Proposition 3 *When investment is finance constrained, ACE and CF taxes* (i) *are equivalent, and* (ii) *reduce investment and welfare.*

How could tax policy succeed to induce first best investment levels? Since any tax reduces cash-flow and constrains investment of financially weak firms, first-best levels can only be achieved if (i) the tax does not change the user cost, as is the case with an ACE or a CF tax; (ii) the net value of tax liability is negative, i.e. the firm must receive cash. Condition (i) implies that the tax does not change the first-best investment scale, indicated by I^{FB} in Fig. 1. Condition (ii) means that a constrained firm receives additional funds from the public. Own funds A are augmented until the incentive constraint 'just binds,' i.e. the line $p\beta I - AR$ in Fig. 1 is shifted down until the intersection point occurs at I^{FB}. ACE and CF taxes have not been designed to address financial frictions. However, as opposed to conventional profit taxes, they tax only *above normal (excess) returns*, but exclude the normal return on capital. They raise less revenue and are, thus, less damaging to constrained investment.[14]

3 Active financial intermediation

In this section, we consider more active forms of financial intermediation and extend Tirole (2006, Chap. 9) to variable investment levels. We show that an ACE tax yields larger investment and welfare than an equal yield cash-flow tax when banks become active and provide monitoring services in addition to finance.

[13] As a referee pointed out, one may draw a parallel to the labor tax literature. If the value of leisure were deductible, a proportional tax would be neutral with respect to labor supply. If foregone private benefits were deductible, the opportunity cost of effort would be $(1 - \tau)bI$. Suppose also that A_0 is the result of past earnings, leaving own funds $A = (1 - \tau)A_0$ after tax. In this case, the tax factor would cancel from (6) and the two systems would be neutral even with a binding financing constraint. Given that financial frictions arise from private benefits being either not observable or not contractible, they can also not be made part of the tax deductions which leads to the non-neutrality of CF and ACE taxes.

[14] Compensating revenue losses by raising other taxes would add distortions elsewhere.

Model Specialized investors such as relationship banks or venture capitalists often play a productive role in the active oversight of firms, give strategic business advice, and thereby add value by raising a firm's survival and growth prospects. We thus introduce an advising and monitoring role of active banks that raises a firm's success probability. As before, high managerial effort raises the success probability to $p > 0$. Shirking, for simplicity, is assumed to result in sure failure, $p_L = 0$. However, the success probability p depends not only on managerial effort but also on a continuous monitoring and advising input. The bank can further raise p by more intensive monitoring but incurs an intangible cost $c(p)I$ which is proportional to investment and convex increasing in p, $c', c'' > 0$.[15] Both types of effort are non-contractible, giving rise to double moral hazard. The surpluses of the entrepreneur and the bank are

$$\begin{aligned} \pi^e &= p\big(I + f - T - \big(1 + i^m\big)D\big) - AR, \\ \pi^b &= p\big(1 + i^m\big)D - DR - c(p)I, \\ \pi &= p(I + f - T) - c(p)I - (1 - \tau s)RI. \end{aligned} \tag{9}$$

As before, $D = (1 - \tau s)I - A$ is external debt while $T = \tau[f - \lambda i^m(D + A) + sI]$ and $G = pT - \tau sIR$ give the value of tax revenue. The loan rate i^m must be set to cover not only the opportunity cost of funds DR but also the monitoring cost $c(p)I$. Monitored finance is more expensive so that the loan rate exceeds the interest which satisfies the no-arbitrage condition $p(1 + i) = R$ and is applied by the government, i.e., $i^m > i$. Further, both rates are endogenous by the choice of monitoring effort which determines p.

At the moral hazard stage, the credit contract, specifying the loan size D and the lending rate i^m, is already given. The managing owner chooses effort, given the bank's monitoring activity. The bank chooses monitoring and advising intensity that maximizes its surplus π^b, given the entrepreneur's effort. The two incentive constraints are

$$\begin{aligned} &\mathrm{IC}^e: \beta(p)I \leqslant v^e = (1 - \tau)\big[f(I) - u^m I\big] + \big(1 + i^m\big)A, \\ &\mathrm{IC}^b: c'(p)I = \big(1 + i^m\big)D, \end{aligned} \tag{10}$$

where the user cost u^m is defined in (3), using i^m, and $\beta = b/p$ since $p_L = 0$.

At the effort stage, interest as well as debt and investment are predetermined. The outstanding credit determines incentives of the bank and the success probability (IC^b-constraint). Anticipating effort choice, firms invest and banks lend more until the managerial incentive constraint binds. Approving a larger loan boosts the bank's surplus by $d\pi^b/dD = [p(1 + i^m) - R - c/(1 - \tau s)] > 0$, which is positive as long as break even $\pi^b = [p(1 + i^m) - R - c/(1 - \tau s)]D - Ac/(1 - \tau s) \geqslant 0$ is not violated. When the two constraints in (10) bind, they jointly determine investment, credit and the success probability. The equilibrium values depend on interest i^m and result in a banking profit.

[15] For simplicity and tractability, we assume that monitoring does not affect p_L. Assuming monitoring costs to be multiplicative in investment allows to relate the success probability (reflecting monitoring intensity) to the interest rate and debt asset ratio D/I, see the optimality condition (10).

Finally, competition among banks forces down the loan rate i^m until profits are zero. Defining the debt ratio $\delta \equiv D/I$, zero profits imply $(p(1+i^m)-R)\delta = c(p)$. The intermediation margin must cover the monitoring cost c and becomes endogenous. In what follows, we assume $c(p) = p^{1+\gamma}/(1+\gamma)$. The specification implies $pc' = (1+\gamma)c$, which, together with the bank's incentive and break-even constraints, yields $p(1+i^m) = R(1+\gamma)/\gamma$. Given the isoelastic specification, the expected repayment per unit of a loan is a constant markup over the exogenous deposit rate.

Comparative statics To avoid complicated tax base effects, we start out from an untaxed equilibrium and limit attention to small taxes only, i.e., we evaluate the differentials at $\tau = 0$ so that $u = i^m$ initially. The Appendix derives the linearized version of the system in (10) where $m = p\beta - \rho$ and $\rho = p(f' - i^m)$ as in Sect. 2.2:

$$\begin{aligned} &\mathrm{IC}^e : m \cdot dI = (I+f) \cdot dp - p\big[f - (\lambda + s) i^m I\big] \cdot d\tau, \\ &\mathrm{IC}^b : (1+\gamma) D \cdot dp = -spI \cdot d\tau + (1-\delta) p \cdot dI. \end{aligned} \tag{11}$$

Given monitoring, the tax reduces investment by eroding cash-flow as before. Given investment, we find that a larger tax erodes monitoring incentives only when there is an immediate allowance $s > 0$. In giving an upfront tax allowance, a CF tax reduces the need for external funding, leads to a smaller outstanding credit volume and, thereby, weakens monitoring incentives.

Monitoring and investment are strategic complements. Monitoring reduces incentives to shirk, $\beta' < 0$, strengthens pledgeable income and allows more externally funded investment. Conversely, higher investment leading to larger outstanding debt boosts monitoring incentives. Both reaction functions are upward sloping in the I, p-space. Stability requires that the IC^e-curve is steeper than the IC^b-curve. Otherwise, investment and monitoring would not converge to finite positive levels after a shock. This condition requires that $\nabla \equiv (1+\gamma) m D - p(I+f)(1-\delta) > 0$, leading to equilibrium changes in I and p:[16]

$$\begin{aligned} dI &= -\frac{pI}{\nabla}\big[\big(f - (\lambda+s) i^m I\big)(1+\gamma)\delta + (I+f)s\big] \cdot d\tau, \\ dp &= -\frac{p}{\nabla}\big[\big(f - (\lambda+s) i^m I\big)(1-\delta) p + msI\big] \cdot d\tau. \end{aligned} \tag{12}$$

The factor $f - (\lambda + s) i^m I$ simplifies to $f - i^m I$ under both taxes. Since $f' > i^m$ with constrained investment, and $f/I > f'$ with a concave technology, this factor is positive. A small profit tax thus reduces both investment and monitoring. In particular, monitoring is discouraged for an ACE tax as well, although it does not directly affect monitoring and advising incentives when $s = 0$, see above. By impairing investment, the ACE tax reduces outstanding credit and weakens monitoring incentives. Finally,

[16] The condition $\nabla > 0$ is fulfilled as long as the firm's own equity is not too high.

when starting from an untaxed equilibrium, the effect on net fiscal revenue is[17]

$$dG = \left[p\left(f - \lambda i^m I + sI\right) - sIR\right] \cdot d\tau. \tag{13}$$

ACE versus CF tax In comparing ACE and CF taxes, we set small tax rates such that both taxes yield the same revenue. Suppose a small CF tax, which defines the tax base by $s = 1$ and $\lambda = 0$, is introduced at a rate $d\tau^{\text{CF}} > 0$. By (12), the tax reduces investment and monitoring intensity by

$$\begin{aligned} dI^{\text{CF}} &= -\frac{p(f - i^m I)(1+\gamma)\delta + p(I+f)}{\nabla} I \cdot d\tau^{\text{CF}}, \\ dp^{\text{CF}} &= -\frac{p(f - i^m I)(1-\delta) + mI}{\nabla} p \cdot d\tau^{\text{CF}}. \end{aligned} \tag{14}$$

Net public revenue grows by $dG^{\text{CF}} = [p(f+I) - IR] \cdot d\tau^{\text{CF}}$. An ACE tax defines the tax base by $s = 0$ and $\lambda = 1$. Raising the same revenue requires

$$p\left(f - i^m I\right) \cdot d\tau^{\text{ACE}} = \left[p(f+I) - IR\right] \cdot d\tau^{\text{CF}}. \tag{15}$$

An equal yield ACE system thus discourages investment and monitoring by

$$\begin{aligned} dI^{\text{ACE}} &= -\frac{[p(f+I) - IR](1+\gamma)\delta}{\nabla} I \cdot d\tau^{\text{CF}}, \\ dp^{\text{ACE}} &= -\frac{[p(f+I) - IR](1-\delta)}{\nabla} p \cdot d\tau^{\text{CF}}. \end{aligned} \tag{16}$$

A CF tax reduces investment and monitoring more than an equal yield ACE tax (see the Appendix for the proof),

$$dI^{\text{CF}} < dI^{\text{ACE}} < 0, \qquad dp^{\text{CF}} < dp^{\text{ACE}} < 0. \tag{17}$$

The welfare consequences of these alternative tax systems are measured by the change in the social surplus $\pi^* = \pi + G = p(I+f) - (R+c)I$:

$$d\pi^* = \left[I + f - Ic'\right] \cdot dp + \left[p\left(1 + f'\right) - R - c\right] \cdot dI. \tag{18}$$

Substituting $c'I = (1 + i^m)D$ from the bank's incentive constraint (10) into the first bracket yields $I + f - (1 + i^m)D = v^e > 0$ when the tax is zero at the outset. Hence, stimulating monitoring boosts the entrepreneur's surplus and, thus, yields a social gain which banks ignore when choosing monitoring. The second bracket in (18) is also positive. Since $f' > i^m$ with a binding constraint, expanding investment with more lending would raise the joint surplus by more than the bank's profit at the margin, $p(1 + f') - R - c > p(1 + i^m) - R - c > 0$, with the difference going to the entrepreneur. The last inequality holds on account of $\pi^b = 0$ and $\delta < 1$ when firms

[17] The government discounts with a lower interest rate $i < i^m$, given by $p(1+i) = R$. The end-of-period value of the upfront tax relief under a CF tax is thus lower than the actual ACE deduction, $dG^{\text{CF}} = p(f - iI)d\tau > dG^{\text{ACE}} = p(f - i^m I)d\tau$. An ACE tax allows deduction of actual interest $i^m I$.

have positive equity. Stimulating investment would thus boost bank profits which firms do not take into account. As neither side is able to fully appropriate the social gains of their activities, investment and monitoring are too low relative to a first best allocation.[18]

Proposition 4 *When investment is constrained and monitoring raises success probabilities*, (i) *ACE and CF taxes both reduce investment*, *monitoring and welfare*, *but* (ii) *are no longer equivalent*. *An ACE system reduces investment*, *success rates and welfare less than an equal yield CF tax*.

In giving an upfront tax allowance, the CF tax requires less external funding and a smaller repayment. It thus reduces the bank's outstanding credit and impairs monitoring incentives. An ACE system, in contrast, provides tax relief at the late return stage and does not reduce external credit. With a larger repayment at risk, banks monitor more intensively which helps to contain failure rates and credit defaults. Better success prospects, in turn, raise the returns to managerial effort which makes it cheaper to incentivize entrepreneurs. Hence, more intensive monitoring feeds back positively on incentive compatible investment. In a setting of double moral hazard, the timing of tax payments becomes important which is more favorable under the ACE tax.

Our analysis connects with the literature on efficiency in double moral hazard relationships, see Holmstrom (1982) or McAfee et al. (1991). To overcome the underinvestment problem and commit themselves to a larger effort, team members could deposit at the beginning an amount of cash with a third party (budget breaker). At the end of the period, the deposit is paid back with interest only if the firm is successful. Since the entrepreneur has no more assets at hand, the deposit simply requires a larger credit. A larger debt strengthens monitoring incentives of the bank while the repayment of the deposit to the firm relaxes the managerial incentive constraint. It can be shown that such a private solution would stimulate investment and monitoring and thereby reduce the need for corrective tax policy. However, such arrangements are not observed in reality because, for example, the third party itself might be subject to moral hazard (see Eswaran and Kotwal 1984). The upshot is that the tax system can play the role of a budget breaker. Moving from a CF to an ACE tax raises the tax liability today (a deposit with the government) and gives tax relief tomorrow (repayment to the firm).

Finally, our results do not depend on the specific modeling of monitoring. In a Separate Appendix,[19] we consider an alternative model where monitoring does not directly add value but imposes active oversight and control to reduce the possibilities for entrepreneurial misbehavior which raises pledgeable income and the firm's financing capacity. Active banks not only provide part of the credit but also certify the good governance of the firm and allow other passive banks to lend more. This alternative framework yields qualitatively identical results, i.e., an ACE tax yields larger investment and welfare than an equal yield CF tax. The mechanism, however, is different. Compared to a CF tax, the ACE system redistributes from unconstrained

[18] First best levels maximize π^* and are implicitly determined by $I + f = Ic'$ and $p(1 + f') = c + R$.

[19] Available on www.alexandria.unisg.ch/publications/54285.

Table 1 Equal yield ACE and CF taxes

Absolute values							
τ^{ACE}	0.000	0.050	0.100	0.150	0.200	0.250	0.300
τ^{CF}	0.000	0.046	0.093	0.142	0.194	0.252	0.319
Index values							
I^{ACE}	1.000	0.962	0.924	0.887	0.849	0.812	0.776
I^{CF}	1.000	0.957	0.912	0.867	0.818	0.766	0.702
p^{ACE}	1.000	0.999	0.998	0.996	0.995	0.993	0.991
p^{CF}	1.000	0.994	0.988	0.980	0.970	0.957	0.936
$\pi^{*\mathrm{ACE}}$	1.000	0.992	0.984	0.975	0.966	0.955	0.944
$\pi^{*\mathrm{CF}}$	1.000	0.985	0.967	0.946	0.920	0.887	0.837

firms, where capital earns a normal return, towards constrained firms, where capital earns an excess return. In redistributing towards constrained firms, it relaxes the financing constraint and boosts investment while both tax systems are neutral with respect to investment of unconstrained firms.

Numerical illustration Our central result in (17) was derived for small tax rates only. We also argued in (13) that the tax base of an ACE tax is smaller since it allows deduction of actual interest which must cover monitoring costs of active banks while the government's discount rate is lower. Hence, an ACE tax would require a larger tax rate compared to an equal yield CF tax. Assuming initial tax rates to be zero keeps calculations simple by avoiding complicated tax base effects, but is clearly a restrictive assumption. We now check by means of a numerical example whether our result is valid also for larger tax rates. We specify $f(I) = f_0 I^{\alpha}$ and $c(p) = c_0 p^{1+\gamma}/(1+\gamma)$ and numerically solve the non-linear (rather than the linearized) model. The model is calibrated so that, in the absence of tax, the equilibrium levels of investment and the success probability are $I = 10$ and $p = 0.8$, respectively. The safe deposit rate of interest is set to 2 % ($R = 1.02$), implying a risky rate of $i = 0.275$. This high rate reflects the assumption that the return is zero when the project fails. Monitoring costs are assumed to be 5 % of investment spending, i.e., $c(p) = 0.05$ initially. Initially, the debt asset ratio is $\delta = D/I = 0.7$, and only 30 % of assets are self-financed with own funds (see, e.g., Tirole 2006, p. 98). The partial cash-flow sensitivity of investment, derived from IC^e in (10), is $dI/dA = p(1+i^m)/m \approx 1.24$ which is consistent with empirical estimates of 1.3 (cf. Fazzari and Petersen 1993; Calomiris and Hubbard 1995; Carpenter and Petersen 2002).

In the first line of Table 1, we raise the ACE tax rate from zero to 30 % in steps of five percentage points. The second line reports the equal yield CF tax rates that raise the same present value of tax revenues in equilibrium. The lower part of the table reports changes in investment levels and success probabilities under either tax regime. The change in the social surplus of firms is a welfare measure. Comparing the first and second columns approximates a small change in equal yield tax rates. In line with the analytical results, we find that an ACE tax reduces the investment scale and the survival probability by less than an equal yield CF tax. The index value of 0.957 means that the CF tax levied at a rate of 4.6 % reduces investment by 4.3 %

which exceeds the reduction by 3.8 % under the equal yield ACE tax. Since the CF tax impairs incentives for advising and monitoring relatively more than an ACE tax, the firm's success probability declines to a larger extent although the size of the effect is rather small. The last two lines also show a relatively larger welfare loss from a CF tax compared to an equal yield ACE tax.

As tax rates rise, the negative impact of taxes gets larger. More importantly, the differential effect of the two tax regimes gets larger as well, making the CF tax increasingly less attractive compared to an equal yield ACE tax. With an ACE tax rate of 30 %, investment would decline by 22.4 % relative to the no tax situation. An equal yield CF tax would reduce investment by almost 30 % instead. The reduction in the success probability and in welfare is larger as well. Interestingly, at moderate levels of taxation, the CF tax rate is lower than the equal yield ACE rate while, at higher levels of taxation, it must exceed the ACE tax rate to yield the same present value of revenue. This must be due to the more negative effect on the tax base under the CF tax. Based on the numerical exercise, we conclude that the CF tax becomes increasingly less attractive relative to an equal yield ACE tax when the government must generate higher levels of revenue.

4 Conclusions

When firms are finance constrained, investment becomes sensitive to net of tax cash-flow. Independent of their impact on the user cost, taxes cut down investment by reducing a firm's pledgeable income and its capacity to raise external funds. This has important implications for tax reform. First, even small taxes lead to a first order welfare loss when firms are constrained. Second, both CF and ACE taxes are no longer neutral with respect to investment. Although avoiding an increase in the user cost of capital, they still reduce cash-flow and, thereby, investment of constrained firms. A third policy implication is that ACE and CF taxes may often not be equivalent as is commonly believed. This non-equivalence tends to be important in situations where financial development and efficiency in banking matters. When banks become active and provide monitoring services in addition to finance, we find that an ACE tax yields larger investment and welfare than an equal yield cash-flow tax. Since innovative firms with large growth prospects relative to own funds are most likely to be constrained and in need of more active forms of finance, our results could be important for the most dynamic sectors of an advanced economy.

Appendix

Proof of (11) The changes in the endogenous variables p, I and, in turn, i^m and u^m affect the (binding) incentive constraints in (10). Taking the differential of IC^e and evaluating at $\tau = 0$ and, in turn, $u^m = i^m$ yields

$$\left[\beta - \left(f' - u^m\right)\right] \cdot dI = A \cdot di^m - I \cdot du^m - \left(f - i^m I\right) \cdot d\tau + (\beta/p) I \cdot dp. \quad (19)$$

Differentiation of (3) yields $du^m = di^m + (1 - \lambda - s) i^m d\tau$. Given the specification of monitoring costs, expected repayment is a constant markup over the deposit rate, implying a relationship $pdi^m = -(1+i^m)\,dp$. Multiplying (19) by p, substituting these results, using $m = p\beta - \rho$ together with $\rho = p(f' - u^m)$ and $D = I - A$ yields

$$m \cdot dI = \big[\beta I + \big(1+i^m\big)D\big] \cdot dp - p\big[f - (\lambda + s)i^m I\big] \cdot d\tau. \tag{20}$$

By (10), evaluated at $\tau = 0$, the first square bracket is equal to $I + f$, which yields the first equation in (11).

Taking the differential of IC^b and evaluating at $\tau = 0$ yields $dD = dI - sI\,d\tau$ and

$$Ic'' \cdot dp + c' \cdot dI = \big(1+i^m\big)(dI - sI \cdot d\tau) + D \cdot di^m. \tag{21}$$

Multiply by p, use $pc'' = \gamma c'$ and $c'I = (1+i^m)D$ as well as $\delta = D/I$, replace $pdi^m = -(1+i^m)\,dp$ and divide by $1+i^m$ to get the second equation in (11).

Proof of (17) We compare the investment response in (12) and (14). The CF tax discourages investment by more than an equal yield ACE tax if (use $D = \delta I$)

$$p(I+f) > (1+\gamma)\big[p\big(1+i^m\big) - R\big]D = (1+\gamma)cI. \tag{22}$$

The last equality reflects the bank's zero profit condition. Using $pc' = (1+\gamma)c$ together with the bank's incentive constraint $Ic' = (1+i^m)D$ shows that the inequality is equivalent to $0 < I + f - (1+i^m)D = v^e$ where the right-hand side equals v^e when evaluated at $\tau = 0$. Noting that the managerial incentive constraint in (10) requires $v^e > 0$ proves the result. Monitoring is reduced more strongly under the CF tax if

$$m > \big[p\big(1+i^m\big) - R\big](1-\delta) \quad \Leftrightarrow \quad (1+\gamma)mD > (1-\delta)p\big(1+i^m\big)D. \tag{23}$$

The second inequality follows from $\pi^b = 0$ together with $(1+\gamma)c = pc'$ and the optimality condition for monitoring. Since $v^e > 0$ is equivalent to $I + f > (1+i^m)D$, we have $0 < \nabla < (1+\gamma)mD - (1-\delta)p(1+i^m)D$ which proves the result.

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