Profit Taxation and Finance Constraints

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Abstract

In the absence of financing frictions, profit taxes reduce investment by their effect on the user cost of capital. With finance constraints due to moral hazard, investment becomes sensitive to cash-flow and own equity of firms. We propose a corporate finance model of investment and derive three central results: (i) Even small taxes impose first order welfare losses on financially constrained firms; (ii) ACE and cash-flow tax systems, which are investment neutral in the neoclassical model, are no longer neutral when firms are finance constrained. (iii) When banks are active and provide external finance together with monitoring services, the two systems not only reduce investment, but are also no longer equivalent. With active banks, investment is subject to double moral hazard and the timing of tax payments becomes important. The ACE system gives tax relief at the return stage and provides better incentives than a cash-flow tax which gives tax relief upfront.

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1 Introduction

When discussing the effects of profit taxation on firms' investment decisions and efficiency, the public finance literature often relies on models with full information where firms have unimpeded access to external capital. 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 that firms are able to raise (cf. the surveys in Shleifer and Vishny, 1997; Stein, 2003). Typically, outside investors cannot verify whether the owners of the firm and their management team exert enough effort or put all available funding to the intended use. The corporate governance mechanisms that must consequently be set up to ensure that external investors receive the appropriate returns can importantly reduce, but not entirely eliminate the problem, and are costly. Hence, firms with profitable investment opportunities are often subject to finance constraints, which prevent them from investing the desired, first best amount of capital (see, among others, Hubbard, 1998; Tirole, 2001, 2006; Aghion, Fally, and Scarpetta, 2007).

This paper investigates the impact of profit taxes on investment when firms are finance constrained.[1] The analysis rests on a stylized corporate finance model similar to Holmstrom and Tirole (1997) and Tirole (2006), in which managerial effort of entrepreneurs is not observable to outsiders. Firms' capacity to raise credit then depends on the amount of pledgeable income they can credibly promise as a repayment to banks. Investment becomes sensitive to cash-flow and own assets. Empirical studies measuring the cash-flow sensitivity of total investment often find that investment expands by a factor of 1.2-1.3 per Dollar of additional free cash-flow (cf. Fazzari and Petersen, 1993; Calomiris and Hubbard, 1995; Carpenter and Petersen, 2002). Diminished internal financial resources thus lead to a cut in external funding and investment. Profit taxes impair investment

[1] For feedback effects of taxes on corporate governance problems see Desai and Dharmapala (2007a,b).

not only by raising the user cost of capital, but also by reducing the firm's pledgeable income and its financing capacity. Since corporate tax rates vary between 20-40% in many countries (cf. OECD, 2007), the resulting reduction in investment can be substantial.

The mechanism by which taxes affect investment is fundamentally different from the neoclassical model with full information and unconstrained investment. Taking account of credit constraints, this paper derives three important results. We first show that profit taxes, by eroding cash-flow and pledgeable income, tighten finance constraints and reduce investment levels, independent of their effect on the user cost of capital. For this reason, even a small tax rate imposes a first order welfare loss. Taxes thus aggravate a preexisting investment distortion when firms are finance constrained in the absence of tax. Efficiency costs are higher when credit constraints are tight, for instance because firms have few own assets but large investment opportunities. To illustrate our analytical results, we calibrate a small model based on stylized empirical facts and show that the marginal cost of public funds in the presence of credit constraints can significantly surpass the corresponding tax cost in the standard unconstrained investment model.

Our second result demonstrates that neither a cash-flow nor an ACE (Allowance for Corporate Equity) tax system is neutral when firms are finance constrained. In the conventional, neoclassical framework, these two tax systems are investment neutral and equivalent when both are required to raise the same present value of tax revenue. The cash-flow tax (recommended by Meade, 1978) allows immediate expensing of investment costs, but denies deduction of financing costs, i.e. interest on debt or imputed interest on equity. The ACE system (as proposed by the Capital Taxes Group of the Institute for Fiscal Studies, 1991) denies immediate investment depreciation but, instead, allows firms to deduct all costs of finance, an imputed return on equity in addition to interest on debt. In both cases, debt and equity are treated equally. Since only economic rents are subject to tax, they are neutral with respect to the investment decision in the absence of finance constraints (see King, 1975; Sandmo, 1979; Boadway and Bruce, 1984, for models under certainty, and Bond and Devereux, 1995, 2003, under uncertainty).

Due to their efficiency properties, these alternative tax systems feature prominently in current discussions of tax reform (e.g. Devereux and Sorensen, 2005; OECD, 2007; Auerbach, Devereux, and Simpson, 2008). The U.S. President's Advisory Panel on Federal Tax Reform (2006) suggested a cash-flow tax while the recommendation of the upcoming Mirrlees Review on 'Reforming the Tax System for the 21st Century' is not yet known but seems to lean towards an ACE system (Griffith, Hines, and Sorensen, 2008; Crawford and Freedman, 2008). Variants of the ACE tax have already been implemented in Croatia, Austria, Belgium, Italy, and Brazil (Klemm, 2007). Our second main result then shows that when firms are finance constrained, neither cash-flow nor ACE tax systems are investment neutral any more. Irrespective of the fact that both systems fully eliminate the tax wedge between the user cost of capital and the market interest rate, they still reduce firms' pledgeable income and investment levels, although to a smaller extent than a tax system without expensing of investment or interest costs. In spite of the detrimental impact on investment, however, we still find the two tax systems to be equivalent as long as bank financing of firms is competitive and passive.

Yet, in practice, banks often play a more involved role and provide monitoring services and advice (cf. Diamond, 1984). In fact, the quality of these services might be considered an important aspect of financial development. Desai, Foley and Hines (2004) report, for example, that multinational companies face substantially different financing costs in different countries. Our third main result therefore relates to a situation where banks' monitoring effort improves the success prospects of firms. The non-contractibility of monitoring leads to a double moral hazard problem where not only the entrepreneur's managerial effort but also the banks' monitoring effort importantly determine the firms' prospects for successful investment. The timing of tax liabilities then becomes important. While the cash-flow tax provides tax relief upfront, the ACE tax gives relief at the late return stage when the cash-flow accrues, but leads to higher outstanding debt. For this reason, the ACE system provides better incentives for monitoring in a situation of double moral hazard. It leads to higher success probabilities and investment levels even if both alternatives are required to raise the same present value of tax revenue! Since investment scale and monitoring effort are too low even in an untaxed equilibrium, the ACE system is superior in welfare terms.

The paper proceeds as follows. Section 2 sets up the basic model with finance constrained investment. Section 3 studies two specific tax regimes, the cash-flow and the ACE tax, and shows that they are equivalent but not neutral when firms are credit constrained. Section 4 derives the superiority of the ACE compared to the cash-flow tax when banks supply credit together with productive monitoring. Section 5 concludes.

2 The Basic Model

The analysis is based on a one period model of investment with moral hazard and risk-neutrality. At the beginning, the firm is endowed with assets or inside equity A, which can be used for investment financing. If the desired investment I exceeds own funds, the firm has to borrow the remaining amount of $D = I - A$ from external sources. We assume that external borrowing is done in the form of debt, new equity is excluded.[2]

Investment can succeed or fail. The success probability depends on managerial effort, which is not observable to outside investors. 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 $p_L < p$. Once effort is chosen, investment risk is resolved. If the firm fails, no revenues are generated and it cannot repay its debt. If it succeeds, debt and taxes are paid, and the entrepreneur consumes her share of the profits. The timing is thus: (i) government policy; (ii) external borrowing and investment; (iii) managerial effort; (iv) outcomes and payments depending on success or failure. As a benchmark, the next section derives the first best equilibrium in the absence of moral hazard.

[2] Our simple two state model cannot distinguish between debt and new outside equity, but this is also not the focus of our analysis. See for instance Ellingsen and Kristiansen (2008) for an interesting but more complicated approach that allows the endogenous determination of outside equity and debt.

2.1 Full Information Benchmark

When managerial effort is verifiable and contractible, investors can enforce the entrepreneur's high effort p and deny her private benefits. The entrepreneur invests inside equity A with opportunity cost AR, $R = 1 + r$, where the deposit rate r is exogenously given. If $I > A$, the firm borrows $D = I - A$. The bank also incurs refinancing costs on the deposit market equal to R per unit of lending. If the firm is successful, its end of period value is $I + f(I)$ where the cash-flow function satisfies $f'(I) > 0 > f''(I)$.[3] Given a loan rate i, the firm then makes a repayment of $(1 + i) D$ to the bank, and the government collects corporate tax, yielding expected tax revenue $T = p\tau f(I)$. To keep the analysis as simple as possible here, we postpone a deduction of interest on debt to Sections 3 and 4. The surplus for the entrepreneur and the bank are given by

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

Perfect competition in bank lending eliminates bank profits ($\pi^b = 0$) and leads to the break-even condition $(1 + i) p = R$. The borrowing rate i must thus exceed the deposit rate r by an intermediation margin that reflects the rate of business failure and subsequent credit losses. The entrepreneur is the residual claimant of the firm and is entitled to the cash-flow after taxes and debts have been paid. Due to the zero profit condition in banking, the entrepreneur's expected surplus is equal to the total private surplus, $\pi^e = \pi$. The investment rule then follows from her maximization of π:

$$f'(I) = \frac{1}{1 - \tau} \cdot i \equiv u. \tag{2}$$

Thus, in the neoclassical model, the firm invests until the return to investment equals the user cost of capital u. Log-differentiating condition (2) shows how a higher corporate tax

[3] In the following, we will suppress the argument I when convenient.

rate τ reduces investment,[4]

$$\hat{I} = -\varepsilon \cdot \hat{\tau}, \quad \varepsilon \equiv -f'/(If'') > 0, \tag{3}$$

where ε is the investment elasticity with respect to the user cost of capital, which changes by $\hat{u} = \hat{\tau}$, where $\hat{\tau} \equiv d\tau/(1-\tau)$. The corporate tax rate thus inflates the user cost of capital and depresses investment below its first best level.

The marginal cost of public funds ($MCPF$) measures how private welfare changes when an additional unit of tax revenue must be raised, $MCPF = -d\pi/dT$. The marginal change in expected tax revenue consists of a direct mechanical effect and a behavioral effect that reduces revenue by eroding the tax base, $dT/d\tau = pf + p\tau f' \cdot dI/d\tau$, or, using (3),

$$dT/d\tau = pf\left[1 - \frac{\tau}{1-\tau}\sigma\varepsilon\right], \quad \sigma \equiv If'/f. \tag{4}$$

Investment being chosen to maximize joint surplus π, a marginal change in the tax rate affects private welfare by $d\pi/d\tau = -pf$. Dividing this by (4) yields the standard formula

$$MCPF = \frac{1}{1 - \frac{\tau}{1-\tau}\sigma\varepsilon}. \tag{5}$$

For tax rates close to zero, the investment distortion vanishes, implying a $MCPF$ of unity. Higher tax rates, however, erode the tax base in proportion to ε and lead to a progressively increasing welfare loss.

2.2 Finance Constrained Investment

The corporate finance literature emphasizes that in many situations entrepreneurial effort is not verifiable to outsiders and thus not contractible (e.g. Tirole, 2006). This creates a moral hazard problem which requires incentives for managerial effort and limits external financing. The entrepreneur decides on her effort level after a bank loan has been secured, so D is already given at this stage. If she chooses to exert high effort, she foregoes private

[4]The hat notation denotes percentage changes relative to initial values, e.g. $\hat{I} \equiv dI/I$. Exceptions to this definition are separately indicated.

benefits but generates a high success probability p. To highlight the reward for effort, we conveniently rewrite the entrepreneur's surplus in (1) as

$$\pi^e = pv^e - AR, \quad v^e \equiv I + (1-\tau) f - (1+i) D. \tag{6}$$

Instead of high effort, the entrepreneur can choose to shirk which reduces the firm's success probability to $p_L < p$, but allows her to consume private benefits B. We assume that these benefits increase linearly with the investment level, $B = bI$, $b > 0$. Thus, the entrepreneur will exert high effort as long as the following incentive constraint is fulfilled:

$$IC^e: \quad pv^e \geq p_L v^e + bI \quad \Leftrightarrow \quad v^e \geq \beta I, \quad \beta \equiv b/(p - p_L). \tag{7}$$

To elicit high effort, outside investors must cede a large enough share v^e to the entrepreneur. Using the definition of v^e in (6), the total after-tax value from successful investment is split between the entrepreneur and the bank, $I + (1-\tau) f = v^e + (1+i)D$. Since the entrepreneur's compensation must be at least βI to keep her properly incentivized, the bank can demand at most $(1+i)D \leq I + (1-\tau) f - \beta I$ as repayment. The right-hand side is the firm's pledgeable income, i.e. the maximum amount it can credibly promise to repay that still assures incentives for high managerial effort.

Repayment and bank lending are, therefore, constrained by pledgeable income. In principle, the firm's own equity A could be so large that the incentive constraint is slack at the optimal investment level in (2). Despite the moral hazard problem, the solution would be the same as in the preceding section. To exclude this case, we impose the following assumption which leads to a credit constrained equilibrium:

$$1 + (1-\tau) f' > \beta > (1-\tau)(f' - u) > 0. \tag{A}$$

The last inequality implies that the (credit constrained) entrepreneur would like to invest more as it would increase her compensation, $dv^e/dI > 0$. When the firm is credit rationed, some profitable investments with a return in excess of the user cost of capital, $f' > u$, cannot be realized. The firm cannot get the additional funds. Starting from a constrained situation of $v^e = \beta I$, larger investment and debt would violate the incentive constraint due to the second inequality. The first inequality implies that an increase in own equity leads to a proportionately larger increase in investment so that there is a positive leverage at the margin (see eq. 9 below). Figure 1 illustrates how compensation v^e in the good state must be above the line βI for external financing to be incentive compatible, leading to constrained investment.

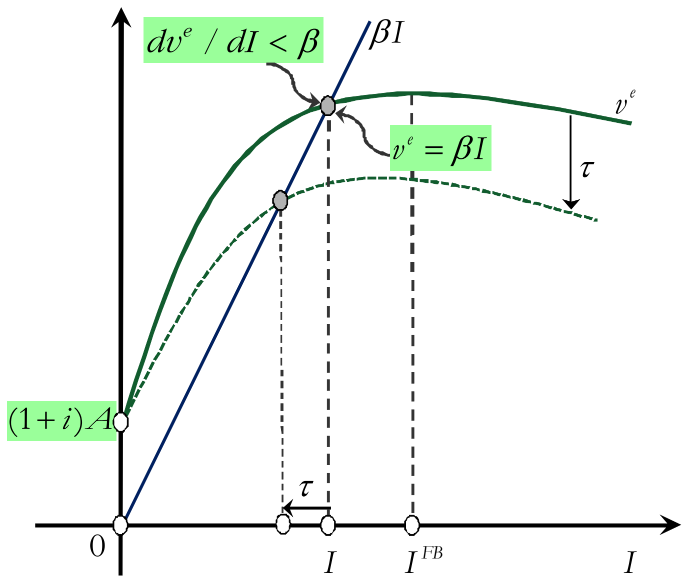

Fig. 1: Constrained Investment

Suppose now that (A) holds. The firm exhausts its debt capacity so that the incentive constraint (7) is binding, $v^e = \beta I$. Investment is thus implicitly determined by

$$(1-\tau)(f-uI)+(1+i)A=\beta I. \tag{8}$$

Assuming that the incentive constraint is also binding after a small change in exogenous parameters, differentiating (8) shows how the investment level depends on the tax rate and on corporate finance variables:

$$\hat{I} = \frac{1+i}{m}\frac{A}{I}\cdot\hat{A} - \frac{\beta}{m}\cdot\hat{\beta} - \varepsilon_c\cdot\hat{\tau}, \quad m \equiv \beta-(1-\tau)(f'-u), \quad \varepsilon_c \equiv \frac{(1-\tau)f}{mI}, \tag{9}$$

where $0 < m < 1+i$ and, thus, $dI/dA > 1$ under assumption (A). The constrained investment level again falls with the profit tax. However, the mechanism is entirely different from the one driven by the user cost of capital in neoclassical investment theory.

Here, the tax liability reduces the firm's pledgeable income that is available for repayment to outside investors. Consequently, less external funding can be obtained and total investment falls (see also Figure 1). It is thus the average tax burden, and not the marginal tax rate (as in the case of unconstrained firms) that determines the distortion in investment behavior. Investment is also sensitive to the corporate governance parameter β. A fall in β implies that the incentive compatible compensation of entrepreneurs can be reduced by better governance mechanisms. This also raises pledgeable income and the firm's borrowing capacity.

Internal funds A play a crucial role for investment behavior in the presence of moral hazard. Under assumption (A), $dI/dA > 1$, i.e. the sensitivity of investment to A exceeds unity at the margin. The firm invests the additional internal funds and at the same time raises more external debt to further expand investment. This scenario is particularly relevant for small and new firms with little internal cash available for self-financing. In more mature firms with larger values of internal funds, the optimal unconstrained investment level might not exhaust their debt capacity, so that the incentive constraint (7) is not binding and investment is determined by (2). Empirical evidence confirms this pattern that credit constraints are severer for small firms (e.g. Schaller, 1993; Jaramillo, Schiantarelli, and Weiss, 1996; Aghion, Fally, and Scarpetta, 2007).

These results have important implications for empirical work concerned with the effects of business taxes on investment. The fundamental differences in investment decisions in constrained and unconstrained firms call for a corresponding decomposition of the business sector. For unconstrained firms, the standard tax augmented user cost of capital is the relevant determinant of investment size. For constrained firms, however, the analysis should take into account measures of own cash or assets and proxies for agency costs. The tax effect is determined by the reduction in pledgeable income that is due to the tax burden and does not depend on measures of marginal effective tax rates.

Marginal Cost of Public Funds: Finance constraints not only change the impact of tax on investment decisions but also fundamentally alter the efficiency properties of the tax and, consequently, its desirability for raising tax revenue. To illustrate this more clearly, we again derive the $MCPF$. Expected tax revenue $T = p\tau f$ reacts to a change in the tax rate as in (4), with the exception that the tax elasticity of investment is now given by ε_c in (9). Using the banks' break-even constraint $R = (1+i)p$ in (1), the derivative of private surplus π becomes $d\pi/d\tau = -pf + p(1-\tau)(f' - u)\, dI/d\tau$, where the term $f' - u$ is strictly positive. When investment is finance constrained, the envelope theorem no longer applies. Inserting the investment response from (9), using the definition $\sigma \equiv If'/f$, and combining with the marginal change in tax revenue yields the $MCPF_c$ in the constrained model,

$$MCPF_c = \frac{1 + \frac{f'-u}{f'}\sigma\varepsilon_c}{1 - \frac{\tau}{1-\tau}\sigma\varepsilon_c} > 1. \tag{10}$$

The main difference to (5) is in the numerator. The extra term arises because investment is not chosen optimally. The credit constraint limits investment at $f' > u$, leaving some profitable opportunities unexploited. Consequently, even small tax rates close to zero impose a first order welfare loss by reducing investment even more, making marginal tax costs exceed unity, $MCPF_c > 1$. Imposing a small tax on credit constrained firms thus induces a higher efficiency loss than a corresponding tax on unconstrained firms.

Proposition 1 *Even a small profit tax rate imposes a first order welfare loss when investment is finance constrained.*

Positive tax rates make a comparison more difficult since the elasticities ε and ε_c are, in general, different. However, in the special case where firms have no own equity ($A = 0$) and technology is Cobb Douglas, it can be shown that $\varepsilon = \varepsilon_c$.[5] Hence, in this case we clearly have $MCPF_c > MCPF$ for all levels of the tax rate. Appendix B provides a calibrated example.

[5] A technology $f = I^\sigma$ implies $\varepsilon = 1/(1-\sigma)$. For the constrained case with $A = 0$, inserting β from (7) into the definition of m yields $mI = (1-\sigma)(1-\tau)f$, leading to $\varepsilon_c = 1/(1-\sigma)$ as well.

3 Non-Neutrality of Cash-Flow and ACE Taxes

The mechanism by which the corporate tax affects investment differs substantially from the one at work in the standard model with full information. Will a tax system that is designed to be investment neutral for unconstrained firms still be efficient in the presence of finance constraints? The cash-flow 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). Since they avoid investment distortions and yet raise revenue, they have attracted a lot of attention in recent discussions of corporate tax reform (see Devereux and Sorensen, 2005; OECD, 2007; Auerbach, Devereux, and Simpson, 2008; Griffith, Hines, and Sorensen, 2008).

To be able to represent both tax systems in our model, we now include a possible deduction of the cost of finance, reflecting the expensing of interest on debt and an imputed cost of equity, and a possibility for immediate expensing of investment. The end of period value of net fiscal revenue is, thus,

$$G = T - \tau s I R, \quad T = p\tau \left[f - \lambda i \left(D + A \right) + sI \right]. \tag{11}$$

At the beginning of the period, a share s of investment outlays can be deducted from the tax base, thus leading to a public subsidy $\tau s I$ at the outset. When capital is disinvested at the end of the period, the upfront subsidy must be repaid. A positive share s thus shifts the tax load from the beginning to the end of the period. The parameter λ determines the share of financing costs (for both debt and equity A) that can be deducted from the tax base at the time the returns from successful investment accrue, and thus reduces the tax liability at the end of the period.

According to Bond and Devereux (1995, equation 6), an ACE tax system 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 ($s = 0$ and $\lambda = 1$) would be $T = \tau p f - \tau r I + \tau \left[p \left(I - I \right) - \left(1 - p \right) I \right]$. 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 $-\tau r I - \tau I$ from interest expensing and the capital loss when the market value falls to zero. Upon rearranging, and noting the no-arbitrage condition $(1+i)\,p = R$, expected tax liability is $T = \tau\,[p\,(I+f) - RI] = \tau p\,(f - iI)$ which corresponds to (11) with an ACE in place, where $I = D + A$. The present analysis assumes deduction of financing costs at the *risky loan rate i without loss-offset.* According to (11), the firm owes $\tau\,(f - iI)$ in case of success, but receives no tax refund when it fails, neither from interest deductions nor from capital losses. The expected tax liability is the same under both assumptions, equal to $T = \tau p\,(f - iI)$. The two alternatives are equivalent.

With the tax system defined as in (11), private surplus amounts to

$$\begin{aligned} \pi^e &= p\,(I + f - (1+i)\,D) - T - AR, \\ \pi^b &= p\,(1+i)\,D - DR, \\ \pi &= p\,(I+f) - T - (1-\tau s)\,IR. \end{aligned} \tag{12}$$

The credit required from banks is given by $D = (1-\tau s)\,I - A$. Due to the subsidy, the government acquires a stake $\tau s I$ in the firm so that private debt and equity need to finance the remaining share of investment only.

In the absence of moral hazard, banks can lend any amount subject to the break even condition $p\,(1+i) = R$ which determines the competitive loan rate i. The entrepreneur chooses an investment level that maximizes her surplus $\pi^e = \pi$,

$$f'(I) = \frac{(1-\tau\lambda)\,(1-\tau s)}{1-\tau} \cdot i \equiv u. \tag{13}$$

Both possibilities of tax deduction $\lambda > 0$ and $s > 0$ now reduce the user cost of capital u. The full information case replicates the neutrality result of Bond and Devereux (2003) for cash-flow and ACE taxes: The cash-flow tax allows for immediate expensing but denies any deduction of the cost of finance, implying $s = 1$ and $\lambda = 0$. The ACE tax, on the other hand, permits full deduction of financing costs, including an imputed cost on equity, but denies an upfront deduction for investment outlays, $s = 0$ and $\lambda = 1$. Both systems yield $f' = i$ in (13) and thus lead to efficient investment decisions when corporate governance problems are absent. Since both systems also imply the same level of net fiscal revenues $G = p\tau (f - iI)$ in (11), cash-flow and ACE taxes are fully equivalent in the unconstrained setting. The only difference between the two systems lies in the timing of tax payments while the present value of tax revenue is the same. This difference in timing is, however, irrelevant in a world without moral hazard.

The question is whether ACE and cash-flow taxes are still efficient and equivalent when investment is finance constrained. Given that the entrepreneur exerts high effort, her expected surplus is $\pi^e = pv^e - AR$, where $v^e \equiv (1-\tau)(f - uI) + (1+i) A$ follows from applying the definition of u from (13) in (12). The need to provide incentives requires that her compensation be $v^e \geq \beta I$, thus putting an upper bound on the firm's financing capacity. Investment is determined by the same condition as in (8) except that the user cost is now given in (13). Differentiation yields

$$\frac{dI}{d\tau} = -\frac{f - uI}{m} - \frac{(1-\tau) I}{m} \cdot \frac{du}{d\tau},$$

where, by assumption (A), $m = \beta - (1-\tau)(f' - u) > 0$. As a concave production function implies $f/I > f'$ and, in addition, $f' > u$ in financially constrained firms, the numerator $f - uI$ of the first term is positive. Both cash-flow and ACE tax systems eliminate the tax wedge so that the user cost is equal to the lending rate, $u = i$, and independent of the tax rate. The tax-induced change in the investment level thus simplifies to $dI/d\tau = -(f - iI)/m$, which is the same in both tax regimes. Clearly, cash-flow and ACE taxes are not neutral with respect to investment when firms are finance constrained. The comparison to (9) shows that the deductions from the tax base, by raising pledgeable income, do reduce the negative investment effects, but cannot entirely eliminate them. However, the quantitative effect on investment levels and, in turn, on the present value of net fiscal revenues $G = p\tau (f - iI)$ are identical.

Proposition 2 *When investment is finance constrained, ACE and cash-flow taxes (i) are equivalent, and (ii) reduce investment.*

The neutrality of ACE and cash-flow taxes in a model with full information (Bond and Devereux, 2003) does not carry over to a situation when firms are financially constrained in their investment decisions. Any tax system that leads to a reduction in pledgeable income has real consequences for investment, independent of the effect on user costs. However, in the simple moral hazard problem considered here, it is only the present value of net tax liabilities that determines the investment distortion. The timing of specific tax and subsidy levels has no additional impact. For any given equity level A, the ACE system implies a larger pledgeable income by giving tax relief at the return stage, but also requires more outside financing because it denies the tax subsidy at the early investment stage. The cash-flow tax, instead, reduces the need for outside financing but also cuts into pledgeable income. ACE and cash-flow taxes turn out to be fully equivalent when banks are passive providers of outside financing.

4 Superiority of ACE Tax With Monitoring

This section extends the basic model by endogenous monitoring of banks. This reflects the productive role of banks in situations where firms are closely associated with one main bank, or of other active intermediaries, which has long been deemed to be a crucial element in the literature on corporate finance (e.g. Diamond, 1984). Indeed, monitoring is a main reason for the existence of financial intermediation and probably an indicator of financial sector development. We show that the timing of tax liabilities now becomes important: monitoring incentives of banks will be stronger the larger their stake in the returns to monitoring, i.e. the larger is the repayment if the firm is successful. A cash-flow tax system provides an upfront subsidy to business investment and thereby reduces the need for external financing. Consequently, repayment is smaller which impairs monitoring incentives of banks and leads to larger failure rates. The lower success probability, in turn, erodes the entrepreneurs' incentives and makes it more expensive to incentivize them. When insiders must keep a larger stake to assure full effort, pledgeable income declines and externally financed investment falls as well.

A Model With Monitoring: To formalize the argument, we introduce an advising and monitoring role of banks that improves a firm's success probability. As before, high managerial effort leads to a high success probability $p > 0$. Shirking, for simplicity, is assumed to result in a sure business failure, $p_L = 0$. Managerial effort is thus crucial for the survival of the firm. However, the success probability p depends not only on high managerial effort but also on a continuous monitoring decision. The bank can further raise p by more intensive monitoring but incurs an intangible monitoring cost $c(p)I$, which is proportional to the investment level and convex increasing in p, $c', c'' > 0$. Both types of effort are non-contractible, giving rise to a double moral hazard problem. The surplus of the entrepreneur and the bank are now

$$\begin{aligned} \pi^e &= p\,(I + f - (1+i)\,D) - T - AR, \\ \pi^b &= p\,(1+i)\,D - DR - c\,(p)\,I, \quad D = (1-\tau s)\,I - A, \\ \pi &= p\,(I+f) - T - c(p)I - (1-\tau s)\,RI. \end{aligned} \tag{14}$$

The tax T and net fiscal revenues G are given by (11). The tax system again allows for a potential deduction of financing costs and investment expenses.

At the moral hazard stage, the terms of the credit contract, i.e. the loan size D and the lending rate i, are already given. The entrepreneur chooses her effort by comparing her surplus under the two options, given the bank's monitoring activity. The bank chooses monitoring intensity that maximizes its surplus π^b, given the entrepreneur's effort. The two types of effort are strategic complements: monitoring incentives are only positive when managerial effort is high. Conversely, a higher monitoring intensity raises success probability p and, thus, enhances the entrepreneur's return to effort. The two incentive constraints are

$$\begin{aligned} IC^e &: \ \beta\,(p)\,I \leqslant v^e = (1-\tau)\,[f\,(I) - uI] + (1+i)\,A, \\ IC^b &: \ c'\,(p)\,I = (1+i)\,D, \end{aligned} \tag{15}$$

where the user cost of capital u is defined in (13) and $\beta = b/p$ since $p_L = 0$.

The lending rate is determined by competition among banks in the market for business loans. Since the lending rate and the debt and investment levels are already given at the moral hazard stage, the bank's incentive constraint IC^b determines monitoring intensity and thus the success probability p. Anticipating the decisions at the moral hazard stage, firms wish to invest more and banks expand lending as long as the entrepreneur's incentive constraint is slack. Approving a larger loan size boosts the surplus of a bank by $d\pi^b/dD = [p(1+i) - R - c/(1-\tau s)] > 0$, which is positive as long as the break even condition $\pi^b = [p(1+i) - R - c/(1-\tau s)]\, D - Ac/(1-\tau s) \geqslant 0$ is not violated. The credit is thus increased until the anticipated incentive constraint of the entrepreneur is binding. As a result, the two constraints in (15) jointly determine the investment level I and the success probability p. The equilibrium values of the success probability and of investment and credit size depend on the loan rate i and result in a given banking profit.

Competition in the credit market finally forces down the lending rate i and squeezes profits in banking until the zero profit condition binds. Using the definition $\delta \equiv D/I$, break even $\pi^b = 0$ implies $(p(1+i) - R)\, \delta = c(p)$. As opposed to the preceding section, the intermediation margin must now cover the monitoring cost c and becomes endogenous, leading to an endogenous loan rate. In what follows, we assume a functional form $c(p) = p^{1+\gamma}/(1+\gamma)$ for the monitoring cost. The specification implies $pc' = (1+\gamma)\, c$, which, together with the bank's incentive constraint IC^b and break-even condition, yields $p(1+i) = R(1+\gamma)/\gamma$. Given the isoelastic specification, the expected repayment is a constant mark-up over the exogenous deposit rate.

Comparative Statics: To avoid a complicated analysis of tax base effects, we start out from an untaxed equilibrium and limit attention to small taxes only. The goal is, thus, to derive the effects of a small profit tax τ on investment and monitoring intensity. The initial equilibrium being untaxed, we evaluate the differentials at $\tau = 0$ so that $u = i$ initially. In (15), we see that the investment level depends, among other variables, on the user cost of capital. Differentiation of (13) gives the reaction of $\hat{u} = \hat{\imath} + [1 - \lambda - s] \cdot \hat{\tau}$. The lending rate i is determined by the zero profit constraint for banks. Given the above specification of the monitoring cost, the expected return on a bank credit contains a constant mark-up over the deposit rate, and the lending rate thus only changes with the success probability: $i \cdot \hat{\imath} = -(1+i) \cdot \hat{p}$. The differentiation of the entrepreneur's and the bank's incentive constraints (15) then yields

$$\begin{aligned} IC^e &: \; m \cdot \hat{I} = (1 + f/I) \cdot \hat{p} - (f/I - (\lambda + s)\, i) \cdot \hat{\tau}, \\ IC^b &: \; (1+\gamma)\, \delta \cdot \hat{p} = -s \cdot \hat{\tau} + \alpha \cdot \hat{I}, \end{aligned}$$

where we have inserted the changes in u and i from above in IC^e and used $c'p = p^{1+\gamma}$ in the differentiation of IC^b. The share of equity in investment is denoted by $\alpha \equiv A/I$. Both incentive constraints are thus increasing functions in the I, p–space. Stability requires that the slope of IC^e is higher than the slope of IC^b. Otherwise, investment and monitoring intensity would not converge to finite positive levels after an exogenous shock. This condition requires that $\nabla \equiv (1+\gamma)\, \delta m - (1 + f/I)\, \alpha > 0$, leading to equilibrium changes in I and p,[6]

$$\begin{aligned} \hat{I} &= -\frac{1}{\nabla} \left[(f/I - (\lambda + s)\, i)\, (1+\gamma)\, \delta + (1 + f/I)\, s \right] \cdot \hat{\tau}, \\ \hat{p} &= -\frac{1}{\nabla} \left[(f/I - (\lambda + s)\, i)\, \alpha + ms \right] \cdot \hat{\tau}. \end{aligned} \tag{16}$$

Note that the factor $f/I - (\lambda + s)\, i$ simplifies to $f/I - i$ under both cash-flow and ACE taxes. Knowing that $f' > i$ in credit constrained firms, and that $f/I > f'$ due to the concavity of the production function, this expression is positive. The introduction of a small profit tax thus reduces both investment I and the monitoring intensity p. Finally, the effect on net fiscal revenue G is

$$dG = pI \left[f/I - \lambda i + (1 - R/p)\, s \right] \cdot \hat{\tau}. \tag{17}$$

Starting from an untaxed equilibrium excludes complicated tax base effects.

ACE versus Cash-Flow Tax: To compare ACE and cash-flow taxes, we study the consequences of introducing small tax rates such that both taxes yield the same net

[6] Note that m is positive under assumption (A). The condition $\nabla > 0$ is fulfilled as long as the firm's own equity is not too high.

present value of fiscal revenue. What are then the effects on investment and monitoring under the two regimes, and how do they compare in efficiency terms? Suppose a small cash-flow tax which defines the tax base by $s = 1$ and $\lambda = 0$, is introduced at a rate $\hat{\tau}_{CF} > 0$. Inserting into (16) gives the changes in investment and monitoring intensity,

$$\hat{I}_{CF} = -\left[(f/I - i)(1+\gamma)\delta + f/I + 1\right]\frac{\hat{\tau}_{CF}}{\nabla}, \quad \hat{p}_{CF} = -\left[(f/I - i)\alpha + m\right]\frac{\hat{\tau}_{CF}}{\nabla}. \quad (18)$$

The net present value of revenue increases by $dG_{CF} = pI\,(f/I + 1 - R/p) \cdot \hat{\tau}_{CF}$. An ACE tax defines the tax base by $s = 0$ and $\lambda = 1$. To obtain the same present value of revenue, $dG_{ACE} = dG_{CF}$, requires a tax rate of

$$(f/I - i) \cdot \hat{\tau}_{ACE} = (f/I + 1 - R/p) \cdot \hat{\tau}_{CF}. \quad (19)$$

An equal yield ACE system induces changes in investment and monitoring intensity of

$$\hat{I}_{ACE} = -(f/I + 1 - R/p)(1+\gamma)\delta\frac{\hat{\tau}_{CF}}{\nabla}, \quad \hat{p}_{ACE} = -(f/I + 1 - R/p)\alpha\frac{\hat{\tau}_{CF}}{\nabla}. \quad (20)$$

Appendix A proves that a cash-flow tax reduces investment and monitoring intensity to a larger extent than an equal yield ACE tax,

$$\hat{I}_{CF} < \hat{I}_{ACE} < 0, \quad \hat{p}_{CF} < \hat{p}_{ACE} < 0. \quad (21)$$

The consequences of these alternative tax systems for efficiency are measured by the change in the social surplus $\pi^* = \pi + G = p(I + f) - (c + R)I$ as in (14),

$$d\pi^* = [1 + f/I - c']\,pI \cdot \hat{p} + [p(1 + f') - R - c]\,I \cdot \hat{I}. \quad (22)$$

Substituting $c' = (1+i)\delta$ from the bank's incentive constraint (15) into the first bracket yields $1 + f/I - (1+i)\delta = v^e/I > 0$ when the tax rate is initially zero. Hence, stimulating monitoring would boost the entrepreneur's surplus and, thus, yield an additional social gain which banks do not take into account when choosing monitoring intensity. The second bracket in (22) is also positive. Since $f' > i$ with a binding finance constraint, a larger investment scale financed with more lending would raise the joint surplus by more than the bank's profit at the margin, $p(1 + f') - R - c > p(1 + i) - R - c > 0$, with the difference going to the entrepreneur. The last inequality holds on account of $\pi^b = 0$ and $\delta < 1$ when firms have positive equity. Stimulating investment would thus boost bank profits which firms do not take into account. Since neither side is able to fully appropriate the social gains of their activities, investment and monitoring are too low in private equilibrium relative to the first best allocation.[7] Since even a small tax reduces investment and monitoring, it removes their levels further from the first best allocation so that both tax regimes imply a first order welfare loss. Since a cash-flow tax suppresses investment and monitoring to a larger extent, it also imposes a larger efficiency cost relative to an equal yield ACE system. The ACE tax is clearly superior when banks not only supply credit but also perform valuable monitoring services and thereby contribute to lower failure rates in business investment.

Proposition 3 *When investment is finance constrained and bank monitoring improves success probabilities of firms, (i) ACE and cash-flow taxes both reduce investment and monitoring intensity, but (ii) are no longer equivalent. An ACE system reduces investment levels, success rates and efficiency less than an equal yield cash-flow tax.*

Banks providing productive monitoring to firms face a typical hold-up problem: they have to bear the full monitoring cost, but can only capture part of the returns, depending on their stake δ in the firm. In giving an upfront subsidy, the cash-flow tax requires less external funding and therefore a smaller repayment. It thus reduces the banks' stake in the firm and impairs monitoring incentives. An ACE system, in contrast, provides tax relief at the late return stage and, therefore, does not reduce external credit. With a larger repayment at risk, banks monitor more intensively which contributes to lower failure rates. Better success prospects, in turn, raise the returns to entrepreneurial effort which makes it cheaper to incentivize entrepreneurs. Hence, more intensive monitoring feeds back positively on the incentive compatible investment scale of the firm. In a setting of double moral hazard, the timing of tax payments becomes important which is more

[7] By (22), first best monitoring and investment are given by $1 + f/I = c'$ and $p(1 + f') = c + R$.

favorable under the ACE tax. Given that the most innovative firms in the economy are also those which are most likely to face finance constraints, this non-equivalence between ACE and cash-flow taxes could be rather important.[8]

Our analysis connects with the literature on efficiency in double moral hazard relationships, see Holmstrom (1982) or McAfee and McMillan (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.[9] Since the entrepreneur has no more assets at hand, the deposit simply requires a larger credit. The larger credit strengthens monitoring incentives of the bank while the repayment of the deposit to the firm relaxes the entrepreneur's 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 cash-flow to an ACE tax raises the tax liability today (a deposit with the government) and gives tax relief tomorrow (repayment to firm).

5 Conclusions

This paper analyzes the effects of corporate taxation when firms are finance constrained due to moral hazard problems. The key insight of neoclassical investment theory that

[8] Proposition 3 mirrors the findings of Keuschnigg and Nielsen (2004) in the context of venture capital financing where a tax relief at the return stage was also found to provide superior incentives compared to an upfront subsidy. Keuschnigg (2004) has shown that shifting the tax burden from the investment to the return stage spurs long-run growth in innovative industries. These authors, however, allowed only for a fixed investment size while this paper endogenizes investment levels and establishes a close link to the tax reform literature in public finance.

[9] In our model, the budget breaker could pay to the firm an amount $\rho = zR/p$ if the deposit is z.

taxes impair investment by raising the user cost of capital, is no longer complete. Independent of their impact on user cost, taxes cut down investment by reducing a firm's pledgeable cash-flow and its capacity to raise external funds. Investment becomes sensitive to net of tax cash-flow. This has important implications for the efficiency properties of specific tax regimes which differ substantially from the basic neoclassical investment model with full information. First of all, profit taxes impose strictly positive first order welfare losses even when tax rates are small. The welfare cost of taxes, as measured by the marginal cost of public funds, is particularly severe in firms with low internal funds and very tight credit constraints. Second, both cash-flow and ACE taxes are no longer neutral with respect to investment as they are in the basic neoclassical model with full information. Although avoiding an increase in the user cost of capital, they still reduce cash-flow and, thereby, investment of constrained firms. Since young innovative firms with large growth prospects and little own funds are most likely to be finance constrained, the non-neutrality is probably relevant for the most dynamic sectors of an advanced economy.

A third important implication for tax policy is that ACE and cash-flow taxes might not be equivalent as is commonly believed. The paper points to a situation where financial development and efficiency in banking is endogenous. When banks, in addition to giving the required external funds, also perform important monitoring services, the success of business investment not only depends on the effort of inside entrepreneurs but also on monitoring incentives. Given this double moral hazard, the timing of tax payments becomes important. Since an ACE tax gives tax relief at the late return stage, it is better for incentives and leads to larger investment levels and success probabilities than an equal yield cash-flow tax which provides tax relief at the early investment stage.

Appendix

A Investment and Monitoring With Equal Yield Taxes

To show (21), we compare the investment response in (18) and (20). The investment distortion is stronger with a cash-flow tax compared to an equal yield ACE tax if

$$1 + f/I > (1+\gamma)\,\delta\,[p(1+i) - R]\,/p \quad \Leftrightarrow \quad 1 + f/I > (1+i)\,\delta. \tag{A.1}$$

The second inequality follows from the break-even condition $(p\,(1+i) - R)\,\delta = c$, after applying $pc' = (1+\gamma)\,c$ under the isoelastic specification of monitoring cost and using the bank's incentive constraint $c' = (1+i)\,\delta$ in (15). This inequality is fulfilled since the managerial incentive constraint in (15) requires $v^e > 0$ and thus $I + f - (1+i)D > 0$ when evaluated at $\tau = 0$. Monitoring is reduced more strongly under the cash-flow tax if

$$m > (p\,(1+i) - R)\,\alpha/p \quad \Leftrightarrow \quad (1+\gamma)\,\delta m > (1+i)\,\delta\alpha. \tag{A.2}$$

The second inequality follows by the same steps noted above. Since $f/I > i$ under finance constraints and $\delta < 1$, the requirement that $\nabla > 0$ guarantees that this inequality holds.

B Marginal Cost of Public Funds

To illustrate the importance of finance constraints for the cost of profit taxation, we calibrate the $MCPF$ in the constrained and unconstrained model of Section 2 for different tax rates τ. At present, statutory rates typically lie between 20-40% in OECD countries, with a falling tendency (cf. OECD, 2007). We consider the values $\{0, .1, .2, .3, .4\}$ for τ. The empirical literature reports lending rates on business credit around ten percent, so we set $i = .1$ (cf. Petersen and Rajan, 1994; Degryse and Ongena, 2005). Tirole (2006, p. 98) reports a ratio of debt to equity slightly above 2, implying an equity ratio of around one third. We set $\alpha = A/I = .3$ in the baseline scenario, but also consider $\alpha = 0$ to capture the impact of very severe financing problems of young firms. Empirical studies estimating the cash-flow sensitivity of investment support a value of $\mu = dI/dA = (1+i)/m = 1.3$ (cf. Fazzari and Petersen, 1993; Calomiris and Hubbard, 1995; Carpenter and Petersen, 2002). To illustrate the sensitivity of $MCPF_c$ with respect to this parameter, we also consider values $\{1, 1.15\}$. Finally, assuming a Cobb Douglas technology, the capital elasticity of output σ is set to a typical value of $\sigma = .3$. Given parameters τ, i, α, μ, σ, the cash-flow sensitivity $\mu = (1+i)/m$ and the incentive constraint $\beta = (1-\tau) f(I)/I - i + (1+i)\alpha$ from (7) can be solved for I and β:

$$I = \left[\frac{(1-\tau)(1-\sigma)}{(1+i)(1/\mu - \alpha)}\right]^{1/(1-\sigma)}, \quad \beta = (1-\tau)/I^{1-\sigma} - i + (1+i)\alpha, \quad A = \alpha \cdot I. \quad \text{(B.1)}$$

These calibrated values can now be used to compute the $MCPF_c$ according to (10). Table 1 summarizes the results.

Table 1: MCPF with Finance Constraints

$MCPF$	$\tau = 0$	$\tau = .1$	$\tau = .2$	$\tau = .3$	$\tau = .4$
Unconstrained investment:					
$MCPF$	1.000	1.050	1.120	1.225	1.400
Finance constrained investment:					
$\alpha = .3$	1.143	1.177	1.223	1.287	1.385
$\alpha = 0$	1.310	1.376	1.468	1.605	1.835
$\mu = 1$	1.209	1.251	1.307	1.387	1.511
$\mu = 1.15$	1.176	1.214	1.265	1.337	1.447

The first row of results gives the $MCPF$ in the absence of information problems, i.e. when firms are not credit constrained. As discussed above, the excess burden is zero in the untaxed equilibrium, but rises progressively with higher tax rates. The row $\alpha = .3$ gives the results for the benchmark scenario in the model with credit constraints. Here, the $MCPF_c$ is significantly higher for small tax rates, but falls below the value from the neoclassical model when the tax rate is high. This is due to the fact that the elasticity of investment with respect to the tax rate ε_c is lower than the corresponding elasticity in the absence of credit constraints, so a change in the tax rate then has a smaller impact on the $MCPF_c$. The derivative of ε_c shows that this elasticity decreases with higher values of own assets A, meaning that the finance constraint becomes less severe as A rises. So reducing A to zero ($\alpha = 0$) leads to very high efficiency costs of taxation. The two bottom rows in Table 1 show that in situations in which firms can only raise very low levels of outside debt for an additional unit of own funding, the tax-induced reduction in pledgeable income also leads to greater losses in efficiency.

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