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 cashflow 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 tax reform 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 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 issues see Desai and Dharmapala (2008, 2009).

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 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 the quantitative welfare implications, 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 entrepreneurial effort but also the banks' monitoring importantly determine the 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, an ACE system provides better incentives for monitoring in a situation of double moral hazard. It leads to higher success probabilities and investment levels when both alternatives are required to raise the same amount 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. It studies two specific tax regimes, cash-flow and ACE tax systems, and shows that they are equivalent but not neutral when firms are credit constrained. Section 3 derives the superiority of the ACE compared to the cash-flow tax when banks supply credit together with productive monitoring. Section 4 concludes.

2 The Basic Model

2.1 Full Information Benchmark

The analysis is based on a one period model of investment 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 the cash-flow function satisfies $f'(I) > 0 > f''(I)$. 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 equal to $R \equiv 1 + r$. Given an opportunity cost of capital equal to IR, the net value of the investment is $\pi = p(I + f) - IR$ in the absence of tax.[2] An investment with a safe return r is equivalent to a risky investment with a return i only in the good state if the no-arbitrage condition $p(1 + i) = R$ is satisfied. Using this, the expected end of period value is equal to $\pi = p(f - iI)$. In the absence of tax and financial frictions, the value maximizing investment scale is given by $f'(I) = i$.

We first show how profit taxation changes this investment rule. Suppose that the entrepreneur is endowed with own assets or inside equity A and self-finances part of the investment. If the government grants an investment subsidy τsI by allowing a share s of investment outlays to be deducted from the tax base, where τ is a proportional tax rate, private investment spending is $(1 - \tau s) I = D + A$. If investment spending exceeds own

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

funds, the firm has to borrow the remaining amount D from external sources. We assume that external borrowing is done in the form of debt, new equity is excluded.[3] To allow for alternative tax systems, we also include a possible deduction of the cost of finance, reflecting the expensing of interest on debt and an imputed cost of equity. The expected value of net fiscal revenue G at the end of the period amounts to

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

The firm must pay back the upfront investment subsidy τsI when capital is disinvested. 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) that can be deducted from the tax base when the returns from successful investment accrue, and thus reduces the tax liability at the end of the period. The firm pays tax T only if it is successful, giving expected tax revenue pT. The end of period value of the upfront investment subsidy is τsIR.

Given that the government subsidizes a part τsI of total investment spending, a firm with insufficient own funds requires a credit $D = (1 - \tau s) I - A$. The entrepreneur's opportunity cost of equity is AR. Similarly, the bank incurs refinancing costs on the deposit market equal to R per unit of lending. With the tax system defined as in (1), private surplus or net value of the firm is divided according to

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

In the absence of financial frictions, banks can lend any amount subject to the break even condition $p(1+i) = R$. Perfect competition among banks imposes a zero profit condition ($\pi^b = 0$) and determines the borrowing rate i which must exceed the deposit rate r by

[3] 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.

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, $\pi^e = \pi$. Value maximization leads to

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

Thus, in the neoclassical model, 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 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 (3) and thus lead to efficient investment decisions when problems of corporate governance are absent. Using $p(1+i) = R$ in (1), we find that cash-flow and ACE taxes also yield the same level of net fiscal revenue $G = p\tau(f - iI)$ and are, thus, 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 financial frictions.

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). 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 $T = \tau pf - \tau rI + \tau[p(I - I) - (1-p)I]$. 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 $-\tau rI - \tau I$ from interest expensing and full loss-offset when the market value falls to zero. Upon rearranging, and noting the no-arbitrage condition $(1+i)\,p = R$, expected tax liability again is $T = \tau\,[p\,(I+f) - RI] = \tau p\,(f - iI)$ which corresponds to (1) with an ACE in place. 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, neither from interest deductions nor from capital losses. The expected tax liability is the same under both assumptions. The two alternatives are equivalent.

2.2 Finance Constrained Investment

Will a tax system that is designed to be investment neutral for unconstrained firms still be efficient in the presence of finance constraints? To answer this question, we introduce a moral hazard problem which creates a conflict of interest between outside investors and the managing owner. We thus assume that the success probability of the firm 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 $p_L < p$. After effort is chosen, the state of nature materializes. If the firm fails, no revenue is generated and it cannot repay its debt. If it succeeds, debt and taxes are paid, and the entrepreneur consumes residual 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.

The corporate finance literature emphasizes that in many situations 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 chooses effort after a bank loan has been secured, so debt is already given at this stage. To highlight the reward for effort, we rewrite the entrepreneur's surplus in (2), using the definitions of user cost and external debt,

$$\pi^e = pv^e - AR, \quad v^e \equiv I + f - T - (1+i)\,D = (1-\tau)\,(f - uI) + (1+i)\,A. \qquad (4)$$

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:

$$IC^e: \quad pv^e \geq p_L v^e + bI \quad \Leftrightarrow \quad v^e \geq \beta I, \quad \beta \equiv b/(p - p_L). \qquad (5)$$

To elicit high effort, outside investors must cede a large enough stake to the entrepreneur. Using the definition of v^e in (4), the total after-tax value from successful investment is split between the entrepreneur and the bank, $I + f - T = v^e + (1+i)D$. Since the entrepreneur's compensation must be at least βI to keep her properly incentivized, the bank can demand at most $(1+i)D \leq I + f - T - \beta I$ 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 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 (3). 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:

$$1 + i + (1-\tau)\,(f' - u) > \beta > (1-\tau)\,(f' - u) > 0. \qquad \text{(A)}$$

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. 7 below). Figure 1 illustrates how, under these assumptions, the incentive compatibility condition leads to constrained investment.

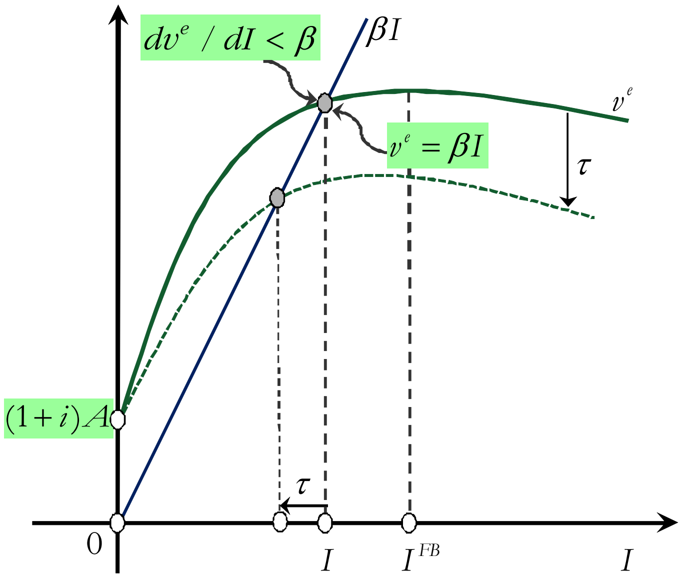

Fig. 1: Constrained Investment

Suppose now that (A) holds. The firm exhausts its debt capacity so that the incentive constraint (5) is binding. Investment is thus implicitly determined by

$$(1-\tau)(f-uI)+(1+i)A=\beta I. \tag{6}$$

Assuming that the incentive constraint is also binding after a small change in exogenous parameters, differentiating (6) shows how the investment level depends on the tax rate and on corporate finance variables:[4]

$$\hat{I}=\frac{1+i}{m}\frac{A}{I}\cdot\hat{A}-\frac{\beta}{m}\cdot\hat{\beta}-\varepsilon_c\cdot\hat{\tau}, \quad m\equiv\beta-(1-\tau)(f'-u), \tag{7}$$

where $dI/dA>1$ under assumption (A). The elasticity with respect to the tax rate is

$$\varepsilon_c\equiv\frac{1-\tau}{mI}\left[(f-uI)+(1-\tau)I\cdot\frac{du}{d\tau}\right].$$

[4]The hat notation denotes percentage changes relative to initial values, $\hat{I}=dI/I$. The exception are tax prices such as $\hat{\tau}=d\tau/(1-\tau)$.

Constrained investment 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). Note that the total tax burden, and not the marginal tax rate (as in the case of unconstrained firms), 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 when the governance mechanisms improve so that managerial autonomy and possibilities for shirking are restricted. The savings in managerial compensation also boost pledgeable income and raise 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 (5) is not binding and investment is determined by (3). Empirical evidence confirms this pattern that credit constraints tend to be more relevant for smaller firms (e.g. Beck, Demirgüc-Kunt, and Maksimovic, 2005; Beck and Demirgüc-Kunt, 2006; 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.

The existence of finance constraints not only changes the impact of taxes on investment but fundamentally alters the efficiency properties of the tax as well. In our partial equilibrium model, the appropriate welfare measure is the social surplus generated by 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 $\pi^* = \pi + G = p(f(I) - iI)$ where investment is determined in private equilibrium and depends on the tax rate as in (7). Raising the tax rate changes welfare by

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

The welfare change depends on the behavioral impact of the tax and is proportional to the total wedge between the pre-tax rate of return f' and the market rate of interest i. This wedge is decomposed into a tax wedge $u - i$ and an excess return $f' - u$. The tax wedge depends on the effective marginal tax rate in the usual way.[5] The excess return arises because the financing constraint limits investment to a level where the gross return exceeds the cost of capital, $f' > u$, leaving some profitable investment opportunities unexploited. Figure 1 illustrates.

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

If the tax rate is zero in the initial equilibrium, the user cost is equal to the loan rate, $u = i$, which still leaves an excess return $f' > i$. Introducing a small tax rate reduces investment as in (7) and leads to a first order welfare loss proportional to the excess return on capital, $d\pi^* = p(f' - i)\,dI$. If the firm were unconstrained, it would be able to optimally expand investment until $f' = i$, so that the welfare loss from a small tax would be zero to the first order.

[5] The effective tax rate is defined as $\tau^{eff} = (u - i)/u$ and relates the market loan rate to the pretax rate of return by $\left(1 - \tau^{eff}\right)u = i$.

The question is whether ACE and cash-flow taxes are still efficient and equivalent when investment is finance constrained. 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 restricts investment since it is sensitive to cash-flow. Noting $du/d\tau = 0$ in (7), the impact on investment simplifies to $dI/d\tau = -(f - iI)/m$, where $f > iI$ by concavity and $m > 0$ by Assumption A. Clearly, cash-flow and ACE taxes are not neutral with respect to investment when firms are finance constrained, and the behavioral impact of both tax regimes is identical. In consequence, the present value of net fiscal revenue, $G = p\tau(f - iI)$, 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 on capital of a constrained firm, $d\pi^* = p(f' - i)\,dI$.

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

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. 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.

3 Active Financial Intermediation

This section extends the basic model by introducing a more active form of financial intermediation. Banks often play a productive role in situations where firms are closely tied to one main bank or get financed by other active intermediaries such as venture capital firms. Indeed, monitoring is a main reason for the existence of financial intermediation (e.g. Diamond, 1984) 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 if the outstanding credit and, in turn, the promised repayment is larger. A cash-flow tax system provides an upfront subsidy to 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.

3.1 A Model of Active Banks

To formalize the argument, we introduce an advising and monitoring role of banks that raises a firm's success probability and, thereby, the likelihood of repayment. As before, high managerial effort leads to a high success probability $p > 0$. Shirking, for simplicity, is assumed to result in sure failure, $p_L = 0$, i.e. 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 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

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

Debt $D = (1-\tau s)\,I - A$, tax T and net fiscal revenues G are as before, see (1).

At the moral hazard stage, the credit contract, specifying the loan size D and the lending rate i, is already given. The entrepreneur chooses effort, 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 return to entrepreneurial effort. The two incentive constraints are

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

where the user cost of capital u is defined in (3) and $\beta = b/p$ since $p_L = 0$.

The lending rate is determined by competition among banks in the market for 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 (10) 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 per unit of a loan is a constant mark-up over the exogenous deposit rate.

3.2 Comparative Statics

To avoid complicated 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 (10), we see that investment depends, among other variables, on the user cost. Differentiation of (3) gives the reaction of $\hat{u} = \hat{\imath} + (1 - \lambda - s)\hat{\tau}$. 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 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 in IC^e and used $c'p = p^{1+\gamma}$ in the differentiation of IC^b. The share of equity 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]

$$\begin{aligned} \hat{I} &= -\frac{1}{\nabla}\left[\left(f/I - (\lambda+s)\,i\right)(1+\gamma)\,\delta + (1+f/I)\,s\right]\cdot\hat{\tau}, \\ \hat{p} &= -\frac{1}{\nabla}\left[\left(f/I - (\lambda+s)\,i\right)\alpha + ms\right]\cdot\hat{\tau}. \end{aligned} \tag{11}$$

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 and the monitoring intensity. Finally, the effect on net fiscal revenue is

$$dG = pI\left[f/I - \lambda i + (1-R/p)\,s\right]\cdot\hat{\tau}. \tag{12}$$

Starting from an untaxed equilibrium excludes complicated tax base effects.

3.3 ACE versus Cash-Flow Tax

In comparing ACE and cash-flow systems, we set small tax rates such that both taxes yield the same net value of government 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 $\hat{\tau}_{CF} > 0$. By (11), investment and monitoring intensity change by

$$\hat{I}_{CF} = -\frac{(f/I - i)\,(1+\gamma)\,\delta + f/I + 1}{\nabla}\cdot\hat{\tau}_{CF}, \quad \hat{p}_{CF} = -\frac{(f/I - i)\,\alpha + m}{\nabla}\cdot\hat{\tau}_{CF}. \tag{13}$$

Net public revenue grows by $dG_{CF} = pI\,(f/I + 1 - R/p)\cdot\hat{\tau}_{CF}$. An ACE tax defines the tax base by $s=0$ and $\lambda=1$. Raising the same revenue, $dG_{ACE} = dG_{CF}$, requires

$$(f/I - i)\cdot\hat{\tau}_{ACE} = (f/I + 1 - R/p)\cdot\hat{\tau}_{CF}. \tag{14}$$

[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.

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

$$\hat{I}_{ACE} = -\frac{(f/I + 1 - R/p)(1+\gamma)\delta}{\nabla} \cdot \hat{\tau}_{CF}, \quad \hat{p}_{ACE} = -\frac{(f/I + 1 - R/p)\alpha}{\nabla} \cdot \hat{\tau}_{CF}. \quad (15)$$

A cash-flow tax reduces investment and monitoring more than an equal yield ACE tax,

$$\hat{I}_{CF} < \hat{I}_{ACE} < 0, \quad \hat{p}_{CF} < \hat{p}_{ACE} < 0. \quad (16)$$

To see this, we compare the investment response in (13) and (15). The cash-flow tax discourages investment by more than an equal yield ACE tax if

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

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 (10). This inequality is fulfilled since the managerial incentive constraint in (10) 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

$$m > [p(1+i) - R]\alpha/p \quad \Leftrightarrow \quad (1+\gamma)\delta m > (1+i)\delta\alpha.$$

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.

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

$$d\pi^* = [I + f - Ic']p \cdot \hat{p} + [p(1+f') - R - c]I \cdot \hat{I}. \quad (17)$$

Substituting $c'I = (1+i)D$ from the bank's incentive constraint (10) into the first bracket yields $I + f - (1+i)D = v^e > 0$ when the tax rate is zero at the outset. 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 (17) 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. As 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] Having seen that 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. However, a cash-flow tax suppresses investment and monitoring to a larger extent and thus 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 constrained and monitoring raises success probabilities, (i) ACE and cash-flow 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 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 bank's outstanding credit 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

[7] By (17), first best monitoring and investment are given by $1 + f/I = c'$ and $p(1+f') = c + R$.

of double moral hazard, the timing of tax payments becomes important which is more 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).

[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.

4 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 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: Marginal Cost of Public Funds

To quantify the welfare consequences of finance constraints, we calibrate a numerical example and compute the marginal cost of public funds ($MCPF$). We limit attention to the case of passive banks with a fixed loan rate as in Section 2 and consider a fully distortive tax with no deductions ($\lambda = s = 0$ and $G = pT = \tau pf$). In the neoclassical model, the firm invests until the return to investment equals the user cost, $f' = i/(1-\tau)$. Log-differentiating condition (3) yields $\hat{I} = -\varepsilon \cdot \hat{\tau}$ with an elasticity $\varepsilon \equiv -f'/(If'')$. The marginal cost of public funds measures the change in private welfare per additional unit of tax revenue, $MCPF \equiv -d\pi/dG$. The change in tax revenue consists of a direct mechanical effect and a behavioral effect that reduces revenue by eroding the tax base, $dG/d\tau = pf + \tau pf' \cdot dI/d\tau = pf\left[1 - \frac{\tau}{1-\tau}\sigma\varepsilon\right]$ where $\sigma \equiv If'/f$. The second equality results when substituting the investment response. 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 the two expressions yields the standard formula

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

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

In the constrained case, the tax elasticity of investment in (7) is $\varepsilon_c = (1-\tau)f/(mI)$ in the present case. Using the no arbitrage condition $R = (1+i)p$, private surplus $\pi = p[(1-\tau)f - iI]$ changes by $d\pi/d\tau = -pf + p(1-\tau)(f'-u)\,dI/d\tau$, where the excess return $f' - u$ is strictly positive. When investment is constrained, the envelope theorem no longer applies. Inserting the investment response and combining with the marginal change in tax revenue yields, for the constrained model,

$$MCPF_c = \frac{1 + \frac{f'-u}{f'}\sigma\varepsilon_c}{1 - \frac{\tau}{1-\tau}\sigma\varepsilon_c} > 1. \tag{A.2}$$

The main difference to (A.1) is in the numerator. The extra term with the excess return $f' - u$ arises because profitable investment opportunities are not fully exploited when the firm is constrained. Consequently, even small tax rates impose a first order welfare loss, making the marginal tax cost strictly larger than unity, $MCPF_c > 1$. Imposing a small tax on credit constrained firms leads to a higher efficiency loss than a corresponding tax on unconstrained firms. 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 $\varepsilon = \varepsilon_c$.[10] Hence, in this case we clearly have $MCPF_c > MCPF$ for all levels of the tax rate.

To illustrate the importance of finance constraints, we calibrate the $MCPF$ in the constrained and unconstrained model 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 loan 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 (6) can be solved for I and β:

$$I = \left[\frac{(1-\tau)(1-\sigma)}{(1+i)(1/\mu - \alpha)}\right]^{1/(1-\sigma)}, \quad \beta = (1-\tau)/I^{1-\sigma} - i + (1+i)\alpha, \quad A = \alpha \cdot I. \quad \text{(A.3)}$$

[10] A technology $f = I^\sigma$ implies $\varepsilon = 1/(1-\sigma)$. For the constrained case with $A = 0$, inserting β from (6) into the definition of m yields $mI = (1-\sigma)(1-\tau)f$, leading to $\varepsilon_c = 1/(1-\sigma)$ as well.

These calibrated values are used in (A.2) to compute the $MCPF_c$:

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
Constrained investment ($\mu = dI/dA = 1.3$)*:*					
$\alpha = .3$	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 $MCPF$ when firms are not constrained. The excess burden is zero in the untaxed equilibrium, but rises progressively with higher tax rates. The row $\alpha = .3$ refers to the benchmark scenario in the model with credit constraints. The $MCPF_c$ measure 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 unconstrained case, 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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