A SIMPLE EXPLANATION FOR THE UNFAVORABLE TAX TREATMENT OF INVESTMENT COSTS

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Abstract

The evidence shows that in most countries the present value of depreciation allowances is less than 100% of the cost of capital. In this article we use a real-option model with debt financing, and show that less favorable depreciation allowances are offset by tax benefits arising from debt financing. Allowing partial deduction of capital cost is thus a necessary condition for investment neutrality to hold.

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1 Introduction

According to standard analysis, investment neutrality requires full deduction of both investment costs and interest expenses.[1] However, the available evidence (e.g. Devereux et al. (2002)) shows that, in most countries, the present value of depreciation allowances is usually less than 100% of the investment cost. This widespread phenomenon, illustrated in Figure 1, may then lead to the conclusion that current tax systems discourage investment.

A recent stream of literature has tried to explain this policy by means of optimal tax theory. In particular, Haufler and Schjelderup (2000) have shown that when foreign direct investments are allowed and firms can shift profits, it is optimal for the governments to allow the partial deductibility of investment costs. Becker and Fuest (2005) have found a similar result if mobile firms are more profitable than immobile firms.

It is worth noting that the above literature disregards the fact that firms' capital structure can be the optimal solution for a trade-off between costs and benefits of debt financing.[2] In this article we provide a simple explanation for the apparently unfavorable tax treatment of investment costs by accounting for the fact that a significant portion of investment is usually debt financed. In particular, we apply a real-option model where the firm can decide not only whether but also when to invest. We will then show that, coeteris paribus, debt financing induces the firm to invest earlier in order to benefit from interest deductibility. As long as full deduction of interest expenses is allowed and firms can optimally choose their capital structure, therefore, less favorable depreciation allowances are offset by tax benefits arising from optimal leverage. This leads to the conclusion that partial deduction of capital cost is a necessary condition for investment neutrality to hold.

The structure of article is as follows. In section 2 we develop the model. In section 3 we analyze firms' decisions on the optimal capital structure and investment timing. Neutrality properties are finally discussed in section 4.

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[1] For instance Brown (1948, p. 537) argues that distortions "can be substantially eliminated by a system which permits the firm to deduct either (1) current outlays (or an average of outlays for a short period) on depreciable assets or (2) normal depreciation on total assets" (p.537). For further details on this literature see Stiglitz (1973) and Sinn (1987).

[2] For a survey on the literature dealing with tax-induced optimal capital structure see Graham (2003).

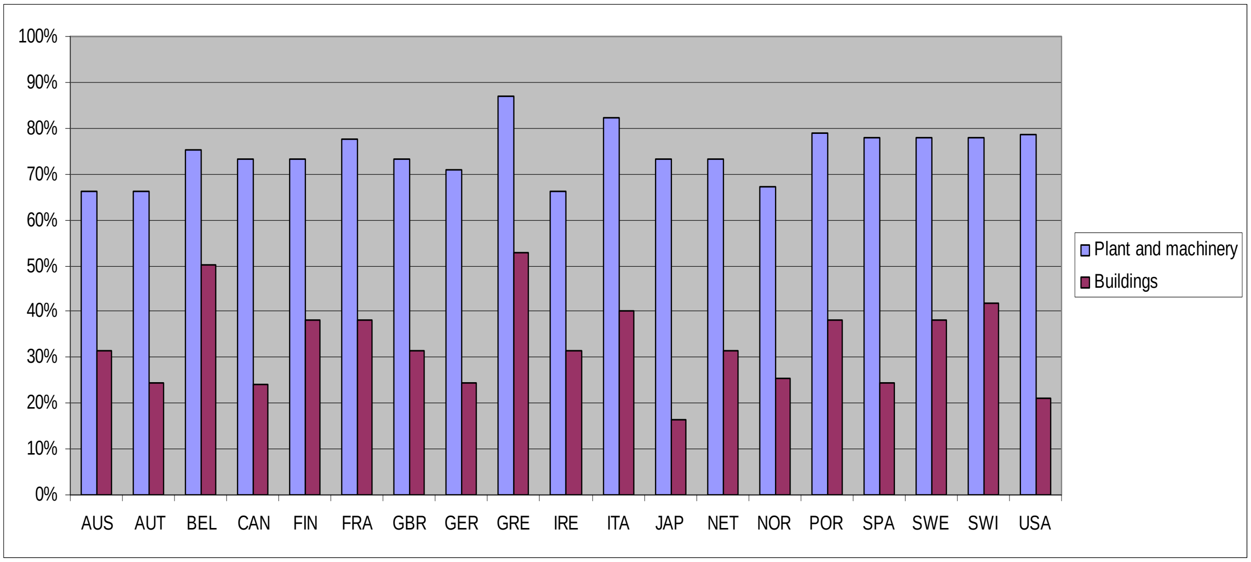

Figure 1: Present discounted value of depreciation allowances in industrialized countries (2005). Source: Klemm (2005) at http://www.ifs.org.uk/

2 The model

In this section we introduce a model describing the financial and investment strategies of a representative firm. We assume that the firm starts to earn a payoff Π_t once an investment cost, denoted as I, has been paid. As time passes, depreciation entails that investment's productivity decreases or, equivalently, maintenance costs raise.

The firm's payoff evolves according to the following geometric Brownian motion

$$d\Pi_t = \alpha \Pi_t dt + \sigma \Pi_t dz_t, \qquad \text{with } \Pi_0 > 0, \tag{1}$$

where $\alpha \equiv \alpha^{'} - \lambda$ is the expected rate of growth, that is given by the difference between the gross-of-depreciation growth rate $\alpha^{'}$ less the depreciation rate λ, which entails a gradual decrease in the project's profitability. Moreover, σ and dz_t are the instantaneous standard deviation and the increment of a standard Wiener process, respectively.

We assume that risk is fully diversifiable, credit markets are perfectly competitive, and information is symmetric. Moreover we assume that:

Assumption 1 *when the firm invests it can borrow some resources and pay a constant coupon* $C \leq \Pi_0$*, that cannot be renegotiated;*

Assumption 2 *default takes place when* Π_t *drops to* C;

Assumption 3 *the cost of default is proportional to the coupon received, namely default cost* υC *with* $\upsilon > 0$.

In line with Leland (1994), assumption 1 entails that the firm sets a coupon and then computes the market value of debt. In the absence of arbitrage, this is equivalent to first set the value of debt and, then, compute the effective interest rate under the non-arbitrage condition. For simplicity, we also assume that debt cannot be renegotiated.[3]

Assumptions 2 and 3 describe default. According to assumption 2 default occurs when the firm does not meet its debt obligation: in particular, default is triggered when the firm's payoff Π falls to the exogenously given threshold point C. This means that debt is *protected*, since condition $\Pi = C$ is a collateral constraint.[4] In the event of default, the firm is expropriated by the lender. According to assumption 3, expropriation causes the lender to face a sunk default cost, υC, that is proportional to the coupon paid.[5]

Let us next introduce taxation. With no loss of generality we assume that when the firm invests it immediately receives a tax rebate equal to $\tau\Omega I$, where τ is the relevant tax rate and Ω is the present value of depreciation.[6] Moreover we assume that, in line with most existing systems, interest payments are fully deductible, so that the firm's tax base is $(\Pi_t - C)$. Finally we assume

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[3] For an analysis of debt renegotiation see e.g. Goldstein et al. (2001).

[4] As pointed out by Leland (1994), minimum net-worth requirements, implied by protected debt, are common in short-term debt financing. It is worth noting that the quality of results would not change if we assumed that debt is unprotected. This kind of debt is more common in long-term debt financing and entails that default timing is optimally chosen by shareholders. For further details on default conditions see Smith and Warner (1977). For a study of corporate taxation under default risk see also Panteghini (2006).

[5] The quality of results does not change if we assume that the cost of default is proportional to the firm value, rather than to the debt value. For a detailed analysis of default costs see e.g. Branch (2002).

[6] Notice that the quality of results would not change if we assumed that fiscal depreciation allowances were deducted year by year. In this case, however, computations would be messy.

that, before default, the lender is tax exempt.[7] After default, however, she becomes shareholder and is thus subject to corporate taxation.

3 The firms' decisions

The firm's problem is thus one of choosing both the investment timing $(T \geq t)$ and the coupon C[8] by maximizing the present value of future after-tax cash flows, i.e.

$$\max_{T>0,C>0} V(\Pi_t; \bar{\Pi}, C) = E_t \left\{ e^{-r(T-t)} \left(\int_T^{\infty} \left[(1-\tau)\left(\Pi_s - C\right) \right] e^{-rs} ds - (1-\Omega\tau) I \right) \right\}, \tag{2}$$

where $E_t\{.\}$ is the expectation operator and r is the exogenously given risk-free interest rate.

It is worth noting that the optimal investment time T corresponds to a trigger point $\bar{\Pi}$. This means that whenever the current payoff reaches $\bar{\Pi}$, the firm invests. Omitting for simplicity the time variable, and defining Π as the current payoff we can thus rewrite (2) as follows (see Appendix A):

$$\max_{\bar{\Pi}>0,C>0} V(\Pi; \bar{\Pi}, C) = \left(\frac{\Pi}{\bar{\Pi}}\right)^{\beta_1} \left[\frac{(1-\tau)\bar{\Pi}}{\delta} + \frac{C}{r}\left(\tau - (\tau + r\nu)\left(\frac{\bar{\Pi}}{C}\right)^{\beta_2} \right) - (1-\Omega\tau) I \right], \tag{3}$$

where $\delta \equiv r - \alpha$.[9] Solving (3) (see Appendix B) we obtain the optimal ratio between C and $\bar{\Pi}$

$$\frac{C}{\bar{\Pi}} = \left(\frac{1}{1-\beta_2} \cdot \frac{\tau}{\tau + r\nu} \right)^{-\frac{1}{\beta_2}}, \tag{4}$$

and the firm's trigger point

$$\bar{\Pi} = \frac{\delta}{1+m(\tau)} \frac{\beta_1}{\beta_1 - 1} \frac{1-\Omega\tau}{1-\tau} I, \tag{5}$$

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[7] Given that effective tax rates on capital income are fairly low, this simplifying assumption does not look unrealistic.

[8] The existence of a trade-off between default costs and tax benefits of debt financing induces the firm to choose the optimal value of C.

[9] The term δ is the so-called convenience (or dividend) yield, which must be positive in order for a solution to be obtained (see Dixit and Pindyck, 1994).

with $m(\tau) \equiv \frac{\tau}{1-\tau}\frac{\delta}{r}\left(\frac{\beta_2}{\beta_2-1}\right)\left(\frac{1}{1-\beta_2}\cdot\frac{\tau}{\tau+r\nu}\right)^{-\frac{1}{\beta_2}} > 0$, $\beta_1 > 1$, and $\beta_2 < 0$.

As shown in (4), the optimal ratio $\left(\frac{C}{\bar{\Pi}}\right)$ is positively related to τ and negatively related to the default cost parameter υ.[10]

Eq. (5) shows that the firm's investment timing depends on financial strategies. In particular the term $\frac{1}{1+m(\tau)}$ measures the leverage effect of debt financing on the firm's trigger point. Given $\frac{1}{1+m(\tau)} < 1$, we can indeed state that debt financing induces the firm to invest earlier. The intuition behind this result is straightforward: if a firm can borrow, it will be stimulated to invest earlier in order to benefit from interest deductibility. We can thus say that full deductibility of interest expenses is equivalent "overinvestment" in a static framework. While the standard notion of "overinvestment" typically refers to the amount spent by the firm, in this context we can use the term overinvestment to define the situation where the expected value of investment at any given time is greater than the *laissez-faire* one. This result will then be used to address our policy implications in terms of neutrality.

4 Investment neutrality

Let us next explore under what conditions the corporation tax is neutral in terms of investment timing. To do so we first set $\tau = 0$ and thus obtain the *laissez-faire* trigger point

$$\Pi^* \equiv \frac{\beta_1}{\beta_1 - 1}\delta I. \tag{6}$$

It is worth noting that setting $\tau = 0$ entails that the tax benefit of debt is null. In the absence of taxation, therefore, the optimal financial strategy is to use only equity finance.[11]

Given (6) we can say that investment timing is unaffected by taxation if the equality

$$\bar{\Pi} = \Pi^* \tag{7}$$

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[10] This results are in line with the empirical evidence provided by Fan et al. (2003). For a detailed discussion on tax-induced debt financing see also Graham (2003).

[11] Notice that the quality of results would not change if we introduced non-tax benefits of debt financing (e.g. related to agency costs). In this case *laissez-faire* investment would be partially debt financed.

holds.[12] If this is true taxation does not distort the investment decision. Substituting (5) and (6) into (7) we obtain

$$\frac{1-\overline{\Omega}\tau}{1-\tau}=1+m\left(\tau\right) \tag{8}$$

where $\overline{\Omega}$ is the value of Ω that ensures neutrality in terms of investment timing. Using (8) we know that $\frac{1-\overline{\Omega}\tau}{1-\tau}>1$. It is thus straightforward to show that investment timing is unaffected by taxation if the present value of fiscal depreciation allowances is

$$\Omega=\overline{\Omega}<1.$$

This result provides a simple explanation for the apparently unfavorable tax treatment of investment. It is indeed shown that less favorable depreciation allowances compensate for tax benefits (and thus leverage effects) arising from debt. As long as full deduction of interest expenses is allowed and firms can optimally choose their capital structure, therefore, the present value of depreciation allowances must be less than 100% in order for investment timing not to be distorted.

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[12] In line with Johansson (1969), we can say that condition (7) ensures an identical ranking in a pre-tax and in a post-tax profitability analysis. For further details on tax neutrality in a real-option setting see Niemann (1999), and Panteghini (2001).

A The computation of (3)

To obtain (3) we must compute both the value of equity and the value of debt. Let us then define $E(\Pi; C)$ as the market value of the equity. Following Leland (1994), we derive its contingent claim value as the solution of the following non-arbitrage condition[13]

$$rE(\Pi; C) = (1-\tau)(\Pi - C) + (r-\delta)\Pi E_{\Pi}(\Pi; C) + \frac{\sigma^2}{2}\Pi^2 E_{\Pi\Pi}(\Pi; C). \quad (9)$$

Solving (9) one obtains

$$E(\Pi; C) = \begin{cases} 0 & \text{after default} \\ (1-\tau)\left(\frac{\Pi}{\delta} - \frac{C}{r}\right) + \sum_{i=1}^{2} A_i \Pi^{\beta_i} & \text{before default,} \end{cases} \quad (10)$$

where $\delta \equiv r - \alpha$. Terms $\beta_1 > 1$ and $\beta_2 < 0$ are the roots of the characteristic equation $\Psi(\beta) = \frac{1}{2}\sigma^2\beta(\beta-1) + (r-\delta)\beta - r = 0$.[14] Let us next compute the constants A_1 and A_2. In the absence of any financial bubbles, A_1 is nil. To compute A_2, notice that default occurs when Π drops to C, namely the condition $E(C; C) = 0$ holds.[15] Using this boundary condition we can thus rewrite (10) as

$$E(\Pi; C) = \begin{cases} 0 & \text{after default} \\ (1-\tau)\left(\frac{\Pi}{\delta} - \frac{C}{r}\right) - (1-\tau)\left(\frac{C}{\delta} - \frac{C}{r}\right)\left(\frac{\Pi}{C}\right)^{\beta_2} & \text{before default.} \end{cases} \quad (11)$$

The value of debt, defined as $D(\Pi; C)$, must satisfy the following non-arbitrage condition

$$rD(\Pi; C) = G + (r-\delta)\Pi D_{\Pi}(\Pi; C) + \frac{\sigma^2}{2}\Pi^2 D_{\Pi\Pi}(\Pi; C), \quad (12)$$

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[13] For further details on mathematical steps see Panteghini (2006).

[14] These roots are $\beta_1 = \frac{1}{2} - \frac{r-\delta}{\sigma^2} + \sqrt{\left(\frac{r-\delta}{\sigma^2} - \frac{1}{2}\right)^2 + \frac{2r}{\sigma^2}} > 1$, and $\beta_2 = \frac{1}{2} - \frac{r-\delta}{\sigma^2} - \sqrt{\left(\frac{r-\delta}{\sigma^2} - \frac{1}{2}\right)^2 + \frac{2r}{\sigma^2}} < 0$, respectively.

[15] Remember that we assumed that debt is protected. For a comparison with default under unprotected debt financing see Panteghini (2006).

where $G = (1-\tau)\,\Pi, C$. The closed-form solution of (12) is:

$$D\left(\Pi; C\right) = \begin{cases} \frac{(1-\tau)\Pi}{\delta} + \sum_{i=1}^{2} B_i \Pi^{\beta_i} & \text{after default,} \\ \frac{C}{r} + \sum_{i=1}^{2} D_i \Pi^{\beta_i} & \text{before default.} \end{cases} \tag{13}$$

To compute B_2 we use the boundary condition $D\left(0; C\right) = 0$, which means that when Π falls to zero the lender's post-default claim is nil. Thus we have $B_2 = 0$. In the absence of any financial bubble, moreover, we have $B_1 = D_1 = 0$. Finally, to compute D_2 we let the pre-default branch of (13) meet with its after-default one, net of the default cost υC, at point $\Pi = C$, i.e.

$$\frac{C}{r} + D_2 C^{\beta_2} = \frac{(1-\tau)\,C}{\delta} - \upsilon C. \tag{14}$$

Solving (14) for D_2 and substituting into (13) thus yields

$$D\left(\Pi; C\right) = \begin{cases} \frac{(1-\tau)\Pi}{\delta} & \text{after default,} \\ \left[\frac{1}{r} + \left(\frac{1-\tau}{\delta} - \frac{1}{r} - \upsilon\right)\left(\frac{\Pi}{C}\right)^{\beta_2}\right] C & \text{before default.} \end{cases} \tag{15}$$

Let us next compute the value function. Using (11) and (15) we then obtain the firm's net present value

$$\begin{aligned} W(\Pi; C) &= E\left(\Pi; C\right) + D\left(\Pi; C\right) - \left(1 - \Omega\tau\right) I = \\ &= \frac{(1-\tau)\Pi}{\delta} + \frac{C}{r}\left[\tau - \left(\tau + r\nu\right)\left(\frac{\Pi}{C}\right)^{\beta_2}\right] - \left(1 - \Omega\tau\right) I. \end{aligned} \tag{16}$$

Given (16) we can rewrite (2) as

$$V(\Pi; \bar{\Pi}, C) = E_t\left[e^{-r(T-t)}\right] \cdot W(\bar{\Pi}; C). \tag{17}$$

Following Harrison (1985), it is easy to ascertain that $E_t\left[e^{-r(T-t)}\right] = \left(\frac{\Pi}{\bar{\Pi}}\right)^{\beta_1}$. Using (17) we thus obtain (3).

B First order conditions

The first order conditions of (3) are

$$\frac{\partial V(\Pi; \bar{\Pi}, C)}{\partial C} = \left(\frac{\Pi}{\bar{\Pi}}\right)^{\beta_1} \frac{1}{r}\left[\tau - \left(1 - \beta_2\right)\left(\tau + r\nu\right)\left(\frac{\bar{\Pi}}{C}\right)^{\beta_2}\right] = 0, \tag{18}$$

$$\frac{\partial V(\Pi;\bar{\Pi},C)}{\partial\bar{\Pi}} = \left(\frac{\Pi}{\bar{\Pi}}\right)^{\beta_1}\left\{\left[\frac{(1-\tau)}{\delta} - \frac{\beta_2}{r}\left(\tau + r\nu\right)\left(\frac{\bar{\Pi}}{C}\right)^{\beta_2-1}\right] - \beta_1\frac{V(\Pi;\bar{\Pi},C)}{\bar{\Pi}}\right\} = 0. \tag{19}$$

Rearranging (18) one easily obtains (4). Substituting (4) into (19) and rearranging thus yields (5).

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