Methods of Mitigating Double Taxation*

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Abstract

This paper presents a comprehensive overview of existing methods of mitigating double taxation of corporate income within a standard cost of capital model. Two of the most well-known and most utilized methods, the imputation and the split rate systems, do not mitigate double taxation in corporations where the marginal investment is financed with retained earnings. However, all methods are effective when the marginal investment is financed with new share issues. The corporate tax rate, fiscal allowances, allocation to periodization funds and allocation to tax equalization reserves (or allowance for corporate equity) are effective instruments, independent of the sources of financing. The paper also discusses why so many different methods have been employed in mitigating double taxation.

Keywords: Corporate Taxation, Double Taxation, Cost of Capital

JEL classification: G32, H25, H32

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1 Introduction

The expression *double taxation* refers to a situation where the income of a corporation is taxed more than once. It is first taxed at the corporate level when arising and then at the shareholder level when distributed. A large number of methods have been used for integrating the two levels of taxation, which may be divided into two different categories. The *trivial* methods are those making use of reduced tax rates or increased allowance rates within an existing tax structure. The *genuine* methods are based on a specific arrangement that reduces the amount of tax paid at the corporate or shareholder level. The imputation system at the shareholder level and the split rate system at the corporate level are the most well-known methods in this second category.

Most of the countries in the EU integrate the two levels of taxation. A full or partial imputation system is found in Finland, France, Italy and the United Kingdom. A couple of countries use a special personal tax rate on dividends; a flat rate in Austria, Belgium and Denmark, and zero in Greece for examples. Sweden uses a method based on a tax-free allocation of a proportion of the corporate income, while only half of the corporate income is taxed at the personal level in Germany. The Netherlands still keeps the classical system of corporate taxation, where corporate and personal taxes are not integrated. Outside the EU, the U.S. also keeps the classical system, while Norway has an imputation system.

The corporate and personal taxes insert a wedge between the pre-tax rate of return on investment and the shareholders' post-tax return. Hence, double taxation of corporate income may result in a higher cost of capital, i.e. the financing cost of the last investment undertaken. The different methods proposed for tax integration are intended to reduce the cost of capital. The discussion of different schemes for reducing double taxation is therefore essentially a discussion of investment incentives, which is also the approach taken in this paper.

Schemes aiming at reducing double taxation take many different forms, but they all reduce the effective tax burden on corporate earnings. In this paper, a number of methods are analyzed in one and the same model, with the ultimate purpose of comparing effective tax rates. We calculate the *King-Fullerton effective tax rates*, i.e. the tax wedges expressed as a percentage of pre-tax returns.[1] As is standard in the literature, the corporation is assumed to maximize the

[1] King and Fullerton (1984).

present value of its future net cash flow to the shareholders, subject to various financial constraints and specific constraints connected with the tax integration schemes. Since all schemes are analyzed within the same model, the results are comparable, and differences and similarities are clearly illustrated. Many of the methods have been modeled and discussed separately in various contexts over the years, but the contribution of this paper is a comprehensive overview and comparison of existing schemes.

Over the past decades, capital has become increasingly internationally mobile, for instance implying that both domestic and foreign investors may be the owners of corporate equity. We assume, however, that the marginal shareholder is a domestic investor in this paper. There are two sources of investment funds, retained earnings and new share issues, and the possible uses of the return of the marginal investment are reinvestment and dividend distribution. The corporation may find itself in one of two regimes, the *retention regime*, where the marginal investment is financed with retained earnings and the *new share issue regime*, where the marginal investment is financed with newly issued equity.[2]

Following this introduction, section 2 contains a comprehensive derivation of a general neoclassical model of firm behavior, which will serve as a benchmark in evaluating the different tax integration schemes. In section 3, we derive the cost of capital for the different schemes under the retention and new share issue regimes. A comparison of the methods is found in section 4. Besides an analytical comparison, clarified through numerical simulations, the King-Fullerton effective tax rate is calculated, allowing a straightforward comparison of the methods. Section 5 summarizes and also adds some other perspectives on the different tax integration schemes.

2 The general model

2.1 The value of the corporation

We will set up a general neoclassical model of firm behavior where the cost of capital is derived under the classical system of corporate taxation. With this system, corporate income is fully taxed at both the corporate and the shareholder level, i.e. no method is employed for integrating the two levels of taxation. The expressions derived for the cost of capital in the

[2] The regimes correspond to the *new* and the *traditional view* of dividend taxation, respectively.

classical system are standard in the corporate taxation literature. The classical system will serve as a benchmark for the subsequent analysis of the different tax integration schemes.[3]

A capital market in equilibrium is characterized by the marginal investor being indifferent between an investment in shares or bonds, which is represented by the following non-arbitrage condition

$$i\left(1-\tau_{pi}\right)V(t_0)=\left(1-\tau_{pd}\right)D(t_0)+\left(1-\tau_{pc}\right)\left(\dot{V}-N(t_0)\right). \tag{1}$$

$V(t_0)$ is the market value of the corporation at time t_0, i is the market interest rate on bonds and τ_{pi} is the personal tax rate on interest income, which means that the term on the left-hand side equals the investor's after-tax return of holding the amount $V(t_0)$ in bonds. $D(t_0)$ is the dividend and τ_{pd} is the personal tax rate on dividend, so that $\left(1-\tau_{pd}\right)D(t_0)$ is the after-tax dividend the investor receives at time t_0. The capital gain from holding shares is given by $\dot{V}$, i.e. the change in market value over time, and τ_{pc} is the tax rate on the capital gain. The net capital gain after tax is given by subtracting $N(t_0)$, the value of new share issues at time t_0, from $\dot{V}$ and multiplying by $\left(1-\tau_{pc}\right)$. Hence, the terms on the right-hand side equal the investor's return from holding shares.[4] Solving (1) forward gives the market value of the corporation as

$$V=\int_{t=t_0}^{\infty}\left(\theta^{gm}D(t)-N(t)\right)e^{-r(t-t_0)}dt, \tag{2}$$

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[3] See Bergström and Södersten (1981) for the set-up of the problem and Sinn (1987) for technical aspects of the optimization problem.

[4] In the non-arbitrage condition (1), there are three different personal tax rates, τ_{pi} on capital income, τ_{pc} on capital gains and τ_{pd} on dividend income. The personal tax rate on capital income is only used for interest income and may or may not be equal to the personal tax rate on dividends. Since the marginal shareholder is assumed to be domestic, the different personal tax rates are also domestic.

where $\theta^{gm} = \frac{1-\tau_{pd}}{1-\tau_{pc}}$ and $r = \frac{1-\tau_{pi}}{1-\tau_{pc}} i$.[5]

2.2 The corporation's budget and financial constraints

The budget constraint follows from the fundamental cash flow constraint, saying that cash inflow must equal cash outflow, i.e. $F(K) + N = D + I + T$, where $F(K)$ is the production function,[6] I is gross investment and T is tax liability. To simplify the expressions, we ignore debt without any loss of generality. The tax liability depends on the corporation's taxable income defined by $\pi \equiv F(K) - \gamma C$, where γ is the fiscal depreciation rate, C is the book value of the capital stock and hence, γC equals the amount of fiscal tax depreciation. If τ is defined as the general corporate tax rate, the tax liability is $T = \tau\pi$. Substituting for T in the cash flow constraint, the corporation's budget constraint becomes

$$D = (1-\tau) F(K) + N - I + \tau\gamma C . \tag{3}$$

As in Auerbach (1984) or Poterba and Summers (1985), we will assume that the corporation distributes dividends and must meet a minimum dividend payout ratio. It must thus issue more shares to fulfill the dividend payout ratio if necessary. This assumption may be motivated by a signaling hypothesis, i.e. the corporation uses dividends for conveying information to the shareholders, or by a free cash flow problem, i.e. the shareholders are interested in minimizing the risk of managerial spending that is not profitable for the corporation. The minimum dividend payout ratio f defines a *dividend floor*

$$D \geq f(1-\tau)\left(F(K) - \delta K\right), \tag{4}$$

i.e. dividends may not fall below a fraction f of the after-tax actual income.[7]

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[5] The index (*gm*) stands for the *general model*. The time index is omitted from now on.

[6] The output price is set to unity, implying that the production function represents the corporation's gross earnings. The production function is assumed to exhibit a positive but diminishing marginal product, $F_K > 0$ and $F_{KK} < 0$, which guarantees a maximum solution to the optimization problem.

[7] Note the difference between the taxable income for tax purposes $F(K) - \gamma C$, affecting the amount of tax paid, and the actual net income $F(K) - \delta K$, affecting dividend payout.

The corporation has two sources of financing, retained earnings, *RE*, and new share issues, *N*.[8] We will distinguish between two different regimes, depending on how the marginal investment is financed. In the first regime, dividends are greater than the floor in (4). The marginal investment is then financed with retained earnings, since the corporation has the possibility of reducing dividends and still meets the minimum payout ratio. This regime is denoted the *retention regime*. In the second regime, the dividend constraint (4) is binding, implying that the corporation cannot reduce dividends. As a consequence, the marginal investment must be financed with a new share issue. This regime is denoted the *new share issue regime*. The distinction will be further clarified when solving the model.

Further, the corporation is not allowed to repurchase its own shares

$$N \geq 0, \tag{5}$$

i.e. dividend payout is the only way for the corporations of distributing income. Finally, changes in the book capital stock and the capital stock depend on investments, and the fiscal and economic depreciation rates, respectively. This gives the equations of motion as

$$\dot{C} = I - \gamma C \tag{6}$$

and

$$\dot{K} = I - \delta K . \tag{7}$$

2.3 The cost of capital and the importance of regime

In order not to reduce the market value of the corporation, the rate of return on new investments must be greater than some minimum rate. This lowest acceptable rate represents the corporate cost of capital and, on the optimal path, it is equated to the first derivative of the production function with respect to the capital stock, $F_K(K)$. Using an Euler equation approach, the problem of maximizing the market value of the corporation, *V*, under constraints (3)-(7), is formalized as

[8] This is illustrated by rewriting the budget constraint (3) as $I = (1-\tau)F(K) + \tau\gamma C - D + N = RE + N$.

$$\text{Max } V(K,C) = \int_{t=t_0}^{\infty} \Lambda\left(K,\dot{K},C,\dot{C},I,N,D;t\right)e^{-r(t-t_0)}dt\,,$$

where
$$\begin{aligned}\Lambda(\cdot) &= \theta^{gm}D - N + \mu_D\left[(1-\tau)F(K) + N - I + \tau\gamma C - D\right] \\ &+\eta_D\left[D - f(1-\tau)\left(F(K)-\delta K\right)\right] + \eta_N N + \mu_C\left[I - \gamma C - \dot{C}\right] + \mu_K\left[I - \delta K - \dot{K}\right].\end{aligned}$$

Here, μ_D, μ_K and μ_C are the Lagrange shadow prices of the budget constraint, the equations of motion for the capital stock and the book capital stock, respectively, while η_D and η_N are the Kuhn-Tucker shadow prices of the minimum constraint on dividends and the non-negative new share issues. The necessary and sufficient first order conditions with respect to *I*, *N*, *D*, *K* and *C* are[9]

I: $\quad -\mu_D + \mu_K + \mu_C = 0\,,$ (8)

N: $\quad -1 + \mu_D + \eta_N = 0\,,$ (9)

D: $\quad \theta^{gm} - \mu_D + \eta_D = 0\,,$ (10)

K: $\quad (\mu_D - f\eta_D)(1-\tau)F_K - \mu_K(\delta + r) + \eta_D f(1-\tau)\delta + \dot{\mu}_K = 0\,,$ (11)

C: $\quad \mu_D\tau\gamma - \mu_C(\gamma + r) + \dot{\mu}_C = 0\,.$ (12)

It follows from expressions (9) and (10) that the corporation cannot both issue new shares and pay dividends in excess of the payout ratio unless $\mu_D = \theta = 1$.[10] This condition holds only when the personal tax rates on dividends and capital gains are equal at the margin.[11] This case is omitted and we instead focus on the *retention regime* ($\mu_D = \theta$) and the *new share issue*

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[9] The first order conditions satisfy the Euler condition $\frac{d\Lambda(\cdot)}{dX} - \frac{\partial}{\partial t}\left(\frac{d\Lambda(\cdot)}{d\dot{X}}\right)$ for the state variables $X = K, C$ and the Lagrange condition $\frac{d\Lambda(\cdot)}{dX} = 0$ for $X = I, N, D$.

[10] With $N > 0 \Rightarrow \eta_N = 0$ and $D > f(1-\tau)\left(F(K) - \delta K\right) \Rightarrow \eta_D = 0$, it is required that $\mu_D = \theta = 1$.

[11] Poterba and Summers (1985) examine the case when, at the margin, personal taxes on capital gains and dividends equal zero. They call this special case the *tax irrelevance view*.

regime ($\mu_D = 1$). We will assume that the corporation is in equilibrium (steady state solution), implying that $\dot{\mu}_K = \dot{\mu}_C = 0$.

The retention regime (RR)

When the corporation is in the retention regime, dividends are greater than the payout ratio, $D > f(1-\tau)(F(K)-\delta K)$, and the amount of new share issues is set to zero, $N = 0$, implying that the Kuhn-Tucker shadow prices are $\eta_D = 0$ and $\eta_N > 0$, respectively. The first order condition for dividends, expression (10), implies that the marginal value of equity, Tobin's marginal q, equals $q \equiv \mu_D = \theta$. Further, from the first order condition with respect to the capital stock, expression (11), the gross cost of capital is derived as[12]

$$F_K^{RR} = \delta + \frac{r}{1-\tau}\left(1 - \frac{\gamma-\delta}{\gamma+r}\tau\right). \tag{13}$$

The net cost of capital, i.e. the gross cost less the economic depreciation δ, depends on the shareholders' required rate of return *r*, the corporate tax rate τ and the rate of accelerated depreciation, $\gamma - \delta$.[13] It is worth pointing out that the term $\frac{\gamma-\delta}{\gamma+r}\tau$ in (13) is a measure, in a present value sense, of the fraction of the marginal investment financed by deferred tax payments due to accelerated depreciation (cf. Södersten (1982)). Hence, the term $1-\frac{\gamma-\delta}{\gamma+r}\tau$ is the fraction of the marginal investment financed by corporate equity. The shareholders' required rate of return, *r*, is adjusted by $(1-\tau)$, thereby reflecting the fact that the shareholders' required rate of return is not tax deductible at the corporate level.

[12] See appendix B for the algebra.

[13] Accelerated depreciation, $\gamma > \delta$, enables the corporation to defer corporate tax payments. This is further discussed in the following as a special method of mitigating double taxation.

To clarify the meaning of (13), substitute $r = \frac{1-\tau_{pi}}{1-\tau_{pc}} i$ and let the fiscal depreciation rate equal the economic depreciation rate, $\gamma = \delta$. The expression for the cost of capital then simplifies to [14]

$$F_K^{RR} = \delta + \frac{\left(1-\tau_{pi}\right)i}{\left(1-\tau\right)\left(1-\tau_{pc}\right)}. \tag{14}$$

Expression (14) shows the cost of capital under a *pure classical system.*[15] The net cost of capital depends on the after-tax return on the alternative investment $\left(1-\tau_{pi}\right)i$, the corporate tax rate τ and the personal tax rate on capital gains τ_{pc}. Note that the personal tax rate on dividends τ_{pd} does not affect the cost of capital, although dividend payout is the only way for the corporation of distributing income. This well-known result is the essence of the new view of dividend taxation.[16] The result in (14) plays a crucial role when evaluating tax integration schemes. We show below that schemes reducing the effective tax burden on distributed income - a reduced personal dividend tax rate or the imputation system for instance - do not affect the cost of capital under the retention regime.

The new share issue regime (NSIR)

Assume next that the dividends are fixed at the minimum level $D = f\left(1-\tau\right)\left(F\left(K\right)-\delta K\right)$, implying $\eta_D \geq 0$, and that the marginal investment is financed with new share issues, i.e. $N > 0$ and $\eta_N = 0$. Expression (9) gives $q \equiv \mu_D = 1$ and from the first order condition with respect to the capital stock, expression (11), the cost of capital is derived as[17]

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[14] The corporate costs of capital expressed, among other things, in terms of the personal tax rates and under the assumption that $\delta = \gamma$ are summarized in appendix C, table C.2, for the different tax integration schemes. We will not derive or discuss those expressions explicitly in the text, but table C.2 merely works as a simplified version to visualize the importance of personal tax rates.

[15] It is common to allow a higher rate of fiscal depreciation than true economic depreciation, i.e. increased allowances, even in a classical system. If the fiscal and the economic depreciation rates are equal, the system is denoted a *pure classical system*.

[16] See, for instance, the review papers of Zodrow (1991) and Sinn (1991b).

[17] See appendix B for the algebra.

$$F_K^{NSIR} = \delta + \frac{r}{1-\tau_{gm}^*}\left(1 - \frac{\gamma-\delta}{\gamma+r}\tau\right), \tag{15}$$

where

$$\tau_{gm}^* = \tau + (1-\tau)\left(1-\theta^{gm}\right) f \ . \tag{16}$$

Comparing expressions (13) and (15), it is clear that the cost of capital takes the same form under the two regimes, but the magnitude may differ depending on the difference between the *adjusted* tax rate τ_{gm}^* and the *statutory* tax rate τ. Moreover, recalling that $\theta^{gm} = \frac{1-\tau_{pd}}{1-\tau_{pc}}$ in the general model (*gm*), it is clear that the difference between τ_{gm}^* and τ captures the tax penalty on dividends as compared to capital gains $\left(\theta^{gm} < 1 \text{ when } \tau_{pd} > \tau_{pc}\right)$.

By rewriting expression (15) by substituting for τ_{gm}^*, θ^{gm} and $r = \frac{1-\tau_{pi}}{1-\tau_{pc}} i$, and imposing the pure classical system assumption $\gamma = \delta$, the cost of capital becomes

$$F_K^{NSIR} = \delta + \frac{\left(1-\tau_{pi}\right) i}{(1-\tau)\left[(1-f)\left(1-\tau_{pc}\right) + f\left(1-\tau_{pd}\right)\right]} . \tag{17}$$

In comparison to the retention regime, see expression (14), the net corporate cost of capital now also depends on the personal tax rate on dividends and the payout ratio.

3 Different methods of mitigating double taxation

3.1 Introduction

The most obvious way of mitigating double taxation at the shareholder level is to reduce the personal tax rates τ_{pd} and τ_{pc}, and, at the corporate level, to reduce the corporate tax rate τ. These changes, or methods, are easily imposed and require no changes in the tax structure as compared to the classical system. Increasing the rate of fiscal depreciation γ, i.e. a deviation from the pure classical system, is also simple. Besides these *trivial* methods, there are several more complicated, or *genuine*, methods.

The imputation system is the most well-known and widely used scheme at the shareholder level today. Although the imputation systems differ among countries, the base line is that shareholders are allowed to credit a fraction of the tax already paid at the corporate level against their personal tax liability. The best-known methods at the corporate level are the split rate system and the dividend deduction. The system currently in use in Sweden permits corporations to allocate part of their income to a so-called periodization fund, free of tax. Other methods that have been used in the past include allocations of before-tax income to a so-called tax equalization reserve and the Annell deduction. According to the Annell-rules, which have attracted international interest,[18] corporations were permitted a limited deduction of dividends on newly issued shares. One alternative suggested in the Swedish debate in the 1990's was the reverse imputation system, a method at the corporate level, where the intention was to allow the corporation a credit for personal taxes on dividends and capital gains paid by the shareholders.

The effects of the trivial methods, i.e. changes in the tax rates in the classical model, on the cost of capital are examined in appendix A. The differences among the genuine methods will be captured in terms of the *adjusted* tax rate, denoted τ^*_{gm} above (see expression (16)) and τ^*_{method} in the following. As explained, τ^*_{method} equals the statutory tax rate τ plus the (remaining) tax penalty on dividends as compared to capital gains. This means that the expression for the cost of capital we derive will take the same form as in the general model, see expressions (13) and (15), but will differ in magnitude due to the differences in the *adjusted* tax rate, τ^*_{method}. The costs of capital for all methods are summarized in appendix C, while table 1 in section 4 below gives the resulting values for τ^*_{method}.

3.2 The imputation system

An imputation system may be designed in many different ways. However, the implication is always a reduced amount of tax paid by shareholders on dividends. Shareholders receive a tax

[18] See, for instance, Handbook of Public Economics, vol. 3, (Auerbach and Feldstein (2002)).

credit for part of the tax already paid by the corporation. To model the imputation system we will follow Södersten (1977) and introduce a 'rate of imputation'-parameter, ϕ, with the following interpretation. If ϕ equals the corporate tax rate for distributed earnings, τ, the shareholder receives full compensation for the amount of tax on distributed income and double taxation is eliminated. If ϕ is less than τ, shareholders are partially compensated for the corporate tax, implying that double taxation is reduced but not eliminated. Hence, with respect to the imputation rate, $\frac{D}{1-\phi}$ is interpreted as the distributed, before-corporate-tax, income, i.e. the imputed shareholder income behind the dividend. The amount of personal tax due to imputed shareholder income is $\tau_{pi}\frac{D}{1-\phi}$ and the amount of credit is $\phi\frac{D}{1-\phi}$. The imputation system is therefore equivalent to levying a personal tax on dividends at the rate $\tau_{pd}=\frac{\tau_{pi}-\phi}{1-\phi}$.[19]

Moreover, we derive the tax discrimination parameter as $\theta^{is}=\frac{1-\tau_{pi}}{\left(1-\tau_{pc}\right)\left(1-\phi\right)}$, where the index (*is*) refers to the imputation system.[20] [21] The adjusted tax rate is hence

$$\tau_{is}^{*}=\tau+\left(1-\tau\right)\left(1-\theta^{is}\right)f\ , \tag{18}$$

where $\tau_{is}^{*}<\tau_{gm}^{*}$, since the imputation system reduces the tax penalty on dividends. An imputation system therefore reduces the cost of capital in the new share issue regime, cf. expression (15) for the classical system. The imputation system has no effect on the cost of

[19] $\tau_{pd}D=\tau_{pi}\frac{D}{1-\phi}-\phi\frac{D}{1-\phi}=\frac{\tau_{pi}-\phi}{1-\phi}D\Rightarrow\tau_{pd}=\frac{\tau_{pi}-\phi}{1-\phi}$

[20] $\theta^{is}=\frac{1-\tau_{pd}}{1-\tau_{pc}}=\frac{1-\frac{\tau_{pi}-\phi}{1-\phi}}{1-\tau_{pc}}=\frac{1-\tau_{pi}}{\left(1-\tau_{pc}\right)\left(1-\phi\right)}$

[21] To be more correct, there exists no specific personal dividend tax rate in an imputation system. In order to fit the expressions into the general model, we have chosen to define a "pseudo" personal tax rate on dividends defined in the text. These algebraic manipulations do not change the result, but is merely a way of simplifying the derivation of the cost of capital, i.e. the same set-up as in the general model can be used.

capital in the retention regime. Instead, the system only implies windfall gains for existing shareholders.[22]

3.3 The split rate system

The split rate system might be the best-known method at the corporate level. Corporate income is taxed at the rate τ_d if distributed to shareholders, and at the rate τ if retained in the corporation. Since the purpose is to reduce double taxation, distributed income is taxed less heavily than retained income, i.e. $\tau_d < \tau$. To find a suitable expression for the tax liability T according to the split rate system, we let $\frac{D}{1-\tau_d}$ be the distributed income before corporate tax. The amount of retained income before-tax is then $\pi - \frac{D}{1-\tau_d}$, where π is the total before-tax income of the corporation. The tax liability can then be expressed as the sum of taxes on distributed and retained corporate income, i.e.

$$T = \tau_d \frac{D}{1-\tau_d} + \tau\left(\pi - \frac{D}{1-\tau_d}\right) = \tau\pi - \left(\tau - \tau_d\right)\frac{D}{1-\tau_d}. \tag{19}$$

Using the definition of total taxable income, $\pi = F\left(K\right) - \gamma C$, and substituting (19) into the budget constraint (3) in the general model, the amount of dividends is given by

$$D = \left(1-\tau_d\right)F\left(K\right) + \varphi\left(N - I + \tau\gamma C\right), \tag{20}$$

where $\varphi = \frac{1-\tau_d}{1-\tau}$ captures the corporate tax discrimination between distributed and retained income. The model may then be solved as in the general model, with the budget constraint (3) replaced by (20).[23] Since the split rate system affects the tax on distributed income, the cost of capital in the retention regime is unaffected. However, the split rate system does affect the adjusted tax rate in the new share issue regime. We derive

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[22] The market value of the corporation is $V = \theta^{is} \int_{t=t_0}^{\infty} De^{-r(t-t_0)}dt$ and $\frac{\partial \theta^{is}}{\partial \phi} > 0$ (compare with expression (2)).

[23] See appendix B for details.

$$\tau_{sr}^{*} = \tau + (1-\tau)\left(\frac{1}{\varphi} - \theta^{gm}\right) f \ , \tag{21}$$

where the index (*sr*) denotes the split rate system. Comparing the adjusted tax rates - expression (16) for the general model and expression (21) for the split rate system - we conclude that the cost of capital is reduced since $\tau_{sr}^{*} < \tau_{gm}^{*}$, i.e. the tax penalty on dividends has decreased.

3.4 Dividend deduction

Another possibility at the corporate level is to allow the corporations a deduction of a fraction β of the amount of dividends distributed. The taxable income is then given by $\pi = F(K) - \gamma C - \beta D$, where βD is the dividend deduction, implying that the budget constraint (3) becomes

$$(1-\tau\beta) D = (1-\tau) F(K) + N - I + \tau\gamma C \ . \tag{22}$$

Following the set-up as in the general model and given the modified budget constraint in (22), we find again that the cost of capital is unaffected in the retention regime.[24] In the new share issue regime, we derive

$$\tau_{dd}^{*} = \tau + (1-\tau)\left(1 - \theta^{gm} - \tau\beta\right) f \ , \tag{23}$$

where the index (*dd*) stands for dividend deduction. Hence, $\tau_{dd}^{*} < \tau_{gm}^{*}$, implying a reduced cost of capital.

3.5 The Annell deduction

We next turn to the specific methods employed in Sweden during the past decades. The first scheme considered, the so-called Annell deduction, is similar to the general dividend deduction described above. Since the early 1960’s and until the minor Swedish tax reform of

[24] See appendix B for details.

1993, Swedish corporations were allowed a deduction of dividends on *newly* issued shares against current profits. A maximum of 10 percent of the value of the new shares could be allocated, for a maximum of 20 years. More formally, let a be the rate of deduction and assume that the deduction can be taken for ω years. After ω years, the entire amount of the new share issue in the initial period is deducted, which means that $a\omega = 1$.[25]

The tax deduction of a fraction a of one unit allocated for ω years is

$$\Omega = \tau a \int_{u=t}^{t+\omega} e^{-r(u-t)} du = \frac{\tau a}{r}\left[1 - e^{-r\omega}\right]. \tag{24}$$

Hence, the value of a new share issue in the hands of the corporation becomes $N + \Omega N = (1+\Omega)N$ and, as a result, the corporate budget constraint (3) now becomes

$$D = (1-\tau)F + (1+\Omega)N - I + \tau\gamma C. \tag{25}$$

From the first order conditions, it follows that the Annell deduction leaves the cost of capital unaffected in the retention regime.[26] When the marginal investment is financed with new equity, the adjusted tax rate τ^*_{annell} becomes

$$\tau^*_{annell} = \tau + (1-\tau)\left(1 - \theta^{gm}(1+\Omega)\right) f. \tag{26}$$

Since $\tau^*_{annell} < \tau^*_{gm}$, the dividend tax penalty is reduced and, hence, the cost of capital will decrease under the new share issue regime as a result of the Annell deduction.

3.6 Allocation to the tax equalization reserve (SURV)

The possibility for corporations of allocating before-tax income to the tax equalization reserve, hereafter SURV[27], was introduced as part of the Swedish tax reform 1990/91, but

[25] If ω equals 10 years, each year the rate of deduction will be 10 percent of the amount of newly issued shares in the initial period.

[26] See appendix B for details.

[27] SURV is the Swedish abbreviation for *SkatteUtjämningsreseRV*, i.e. tax equalization fund.

interrupted after the minor corporate tax reform in 1993. The following way of modelling the SURV was proposed by Shahnazarian (1996). Formally, the base for allocation to the SURV is the book value of the corporations' equity capital and the total amount allocated to the SURV may not exceed a share ξ of the base. The parameter ξ is set to .3, i.e. the maximum amount of accumulated SURV allocations is 30 percent of the book equity. In fact, what really counts is the change in the book equity, since last year's allocation must be returned to taxation in the current year, unless offset by a new allocation to the SURV. The change in the equity capital equals the newly issued equity, plus after-tax income, less dividends. Assuming this change in the equity capital to be positive, the net new allocation to the SURV equals $\xi\dot{C}$. The first order conditions then give the costs of capital in the two regimes as[28]

$$F_K^{RR} = \delta + \frac{r}{1-\tau}\left(1 - \frac{\gamma-\delta}{\gamma+r}\tau - \frac{\xi(r+\delta)}{\gamma+r}\tau\right) \qquad (27)$$

and

$$F_K^{NSIR} = \delta + \frac{r}{1-\tau_{gm}^{*}}\left(1 - \frac{\gamma-\delta}{\gamma+r}\tau - \frac{\xi(r+\delta)}{\gamma+r}\tau\right). \qquad (28)$$

The adjusted tax rate under the new share issue regime turns out to be the same as in the general model, i.e. τ_{gm}^{*}, and the effect of the SURV is instead captured by an additional term in the parenthesis. Clearly, the costs of capital in both regimes are reduced when the allocation to the SURV is imposed, since $\frac{\xi(r+\delta)}{\gamma+r} > 0$ in (27) and (28).[29]

If the corporations were allowed to allocate 100 percent of the change in the book capital, i.e. $\xi = 1$, the corporate tax rate would cancel out from (27) and (28), and, hence, leave the cost of

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[28] See appendix B for details.

[29] In section 4, we will compare the schemes in the new share issue regime when $\delta = \gamma$, and in that case, an adjusted tax rate can be derived as $\tau_{SURV}^{*} = \tau + (1-\tau)\frac{(1-\theta^{gm})f - \xi\tau}{1-\xi\tau}$.

capital unaffected.[30] The meaning of $\xi = 1$ is that the corporation's equity would be untaxed as long as it is not reduced. Instead of taxing income as it accrues, it is taxed when distributed, which means that a 100-percent SURV is, in fact, equivalent to an expenditure tax.

One of the aims of the Allowance for Corporate Equity (ACE), proposed by the Institute for Fiscal Studies (IFS)[31], is to put equity finance, i.e. retained earnings and new share issue, on a similar basis to that of debt finance. To attain this, the corporation would, in principle, be allowed to deduct a certain rate of return on the book equity, reflecting the shareholders' required rate of return. The SURV allocation is easily seen as equivalent to the more widely known scheme ACE, provided that the change in the equity capital is always positive.

3.7 Allocation to the periodization fund

The possibility to allocate funds to the SURV was interrupted as a result of the minor corporate tax reform in 1993. The periodization fund replaced the SURV. Corporations are allowed to defer taxation on 25 percent of each year's income (after depreciation but before corporate tax) for 5 years at most. After 5 years, the corporations must return the fund as taxable income. Formally, let α be the rate of allocation and *n* the period of deferral. The amount returned is included in the base, implying that α^2 can be reallocated to the periodization fund when α is returned after *m* years, α^3 reallocated when α^2 is returned after *2m* years, etc. The easiest way of incorporating the periodization fund in the general model is then to rewrite the corporate tax rate as an effective rate $\tau' = \tau - \tau A_t$, where A_t equals the present value of an allocation in period *t* and, therefore, τA_t equals the tax savings from the periodization fund. With a discount rate *r*, the present value becomes[32]

[30] This is the same effect as in the case where a direct depreciation of investment costs is allowed.

[31] The Institute for Fiscal Studies (IFS) is a research institute located in London with a particular focus on the UK tax system. See further in Gammie (1991).

[32] A_t can be formulated as the geometrical series $A_t = \alpha + \frac{\alpha^2 - \alpha}{(1+r)^m} + \frac{\alpha^3 - \alpha^2}{(1+r)^{2m}} + ... + \frac{\alpha^{n+1} - \alpha^n}{(1+r)^{mn}}$. Rewrite and solve the series as $A_t = 1 + \sum_{t=0}^{\infty} \frac{\alpha^{t+1} - \alpha^t}{(1+r)^{mt}} = 1 - (1-\alpha) \sum_{t=0}^{\infty} \left(\frac{\alpha}{(1+r)^m} \right)^t = 1 - (1-\alpha) \left(\frac{(1+r)^m}{(1+r)^m - \alpha} \right) = \alpha \left(\frac{(1+r)^m - 1}{(1+r)^m - \alpha} \right)$.

$$A_t = \alpha\left(\frac{(1+r)^m - 1}{(1+r)^m - \alpha}\right),$$

and, hence, the effective rate equals

$$\tau' = \tau\left(1 - \alpha\left(\frac{(1+r)^m - 1}{(1+r)^m - \alpha}\right)\right).$$

Hence, the periodization fund affects the cost of capital in the same way as a reduced tax rate on corporate income.[33] Since $\frac{\partial \tau'}{\partial \alpha} < 0$, a higher value of α implies a lower cost of capital, a conclusion valid for both regimes.

3.8 The reverse imputation system

The reverse imputation system proposed by Lodin and Södersten (cf. Mutén (1995) and SOU (1996)) in the mid 1990's in Sweden has not been put to work. As the name reveals, the reverse imputation system is an imputation system but with a reverse procedure. The corporation receives a tax credit when calculating its tax liability, corresponding to the amount of tax paid by the shareholders. The corporate tax liability is therefore

$$T = \tau\pi - \varepsilon\left(\tau_{pd} D + \tau_{pc}\left(\dot{V} - N\right)\right), \qquad (29)$$

where $\varepsilon\tau_{pd} D$ and $\varepsilon\tau_{pc}\left(\dot{V} - N\right)$ constitute the amount of personal tax due on dividends and capital gains, respectively. The *rate of reverse imputation*, ε, takes values between 0 and 1. If ε equals 1, the corporations receive full compensation for the tax paid by the shareholders on distributed income (dividends and capital gains) and double taxation is eliminated. The total tax rate on corporate income then equals the corporate tax rate. If ε is less than one,

[33] In section 4, we will compare the adjusted rates of the different schemes in the new share issue regime. The adjusted rate becomes $\tau_{pf}^* = \tau + (1-\tau)\left(1-\theta^{gm}\right) f - \tau\alpha\left(\frac{(1+r)^m - 1}{(1+r)^m - \alpha}\right)\left(1 - \left(1-\theta^{gm}\right) f\right)$ for the periodization fund (see table 1).

corporations are only partially compensated for individual taxes. The costs of capital become[34]

$$F_K^{RR} = \delta + \frac{r^{ris}}{1-\tau}\left(1 - \frac{\gamma-\delta}{\gamma+r^{ris}}\tau\right), \tag{30}$$

and

$$F_K^{NSIR} = \delta + \frac{r^{ris}}{1-\tau_{ris}^{*}}\left(1 - \frac{\gamma-\delta}{\gamma+r^{ris}}\tau\right), \tag{31}$$

where $r^{ris} = r\dfrac{1-\varepsilon\tau_{pd}}{1-\varepsilon\left(1-\theta^{gm}\right)}$, $\theta^{ris} = \theta^{gm}\dfrac{1}{1-\varepsilon\left(1-\theta^{gm}\right)}$ and

$$\tau_{ris}^{*} = \tau + (1-\tau)\left(1-\theta^{ris}\right) f, \tag{32}$$

and the index (*ris*) refers to the reverse imputation system. Unlike the conventional imputation system, which only affects the cost of capital in the new share issue regime, the reverse imputation system reduces the cost of capital in both regimes. This is clear since $r^{ris} < r$, $\theta^{gm} < \theta^{ris}$ and $\tau_{ris}^{*} < \tau_{gm}^{*}$, which is explained by the fact that corporations are allowed to credit both dividends and capital gains taxes.[35]

4 Overview of the results and the King-Fullerton effective tax rate

4.1 Summary of the methods

The costs of capital, net of the economic depreciation, for the different methods are summarized in appendix C, tables C.1 ($\gamma = \delta$) and C.2 ($\gamma \neq \delta$). In the following illustrations of the results, we will use the pure classical system with $\gamma = \delta$ as the benchmark. 4 out of the

[34] See appendix B for details.

[35] In section 4, we will compare the schemes when $\delta = \gamma$ under the new share issue regime and, in that case,

$F_K^{NSIR} = \delta + \dfrac{r}{1-\tau_{ris}^{*}}$ with $\tau_{ris}^{*} = \tau + (1-\tau)\dfrac{\left(1-\theta^{gm}\right)(1-\varepsilon) f - \varepsilon\tau_{pc}\theta^{gm}}{1-\varepsilon\tau_{pd}}$.

8 genuine methods examined, viz. the imputation system, the split rate system, the Annell deduction and the dividend deduction, have no effect on the cost of capital in the retention regime. The cost of capital takes the form

$$F_K^{RR} = \delta + \frac{r}{1-\tau}, \tag{33}$$

which is the same expression as in the classical system.[36] The reverse imputation system, allocations to the SURV and the periodization fund do affect the cost of capital in the retention regime, see tables C.1 and C.2 in appendix C.

In the new share issue regime, all methods we have considered affect the cost of capital, which takes the general form

$$F_K^{NSIR} = \delta + \frac{r}{1-\tau_{method}^{*}}. \tag{34}$$

The characteristics of each method are captured in the adjusted tax rate τ_{method}^{*} when the rates of fiscal and economic depreciation coincide. All methods would have the same effect on the cost of capital if the adjusted tax rates, summarized in table 1, were equal.[37]

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[36] Note that the term $\left(1-\dfrac{\gamma-\delta}{\gamma+r}\tau\right)$ vanishes since $\gamma=\delta$. Compare to expression (13).

[37] Note that the trivial methods, i.e. changes in existing tax rates within a pure classical system, all follow from the adjusted tax rate for the classical system, τ_{gm}^{*}. We will not report these separately here, even though incorporated in the numerical illustrations below.

Table 1. The adjusted tax rate τ^*_{method}.

Method	The effective tax rates
The classical system	$\tau+(1-\tau)(1-\theta^{gm})f$
The imputation system	$\tau+(1-\tau)(1-\theta^{is})f$
The split rate system	$\tau+(1-\tau)\left(\frac{1}{\varphi}-\theta^{gm}\right)f$
Dividend deduction	$\tau+(1-\tau)(1-\theta^{gm}-\tau\beta)f$
The Annell deduction	$\tau+(1-\tau)(1-(1+\Omega)\theta^{gm})f$
The SURV	$\tau+(1-\tau)\frac{(1-\theta^{gm})f-\xi\tau}{1-\xi\tau}$
The periodization fund	$\tau+(1-\tau)(1-\theta^{gm})f-\tau\alpha\left(\frac{(1+r)^m-1}{(1+r)^m-\alpha}\right)(1-(1-\theta^{gm})f)$
The reverse imputation system	$\tau+(1-\tau)\frac{(1-\theta^{gm})(1-\varepsilon)f-\varepsilon\tau_{pc}}{1-\varepsilon\tau_{pd}}$

Note: See appendix C, table C.1, for variable definitions. Remember the definition $\theta^{gm}=\frac{1-\tau_{pd}}{1-\tau_{pc}}$ and hence, the adjusted tax rate τ^*_{method} equals the statutory corporate tax rate plus any (remaining) tax penalty on dividends (as compared to the taxation of capital gains).

From the adjusted tax rates in table 1, it is also straightforward to derive the parameter values required for all methods to have the same impact on the cost of capital.

4.2 Numerical illustrations

The relationships between the genuine and trivial methods of mitigating double taxation may be further clarified by using a few numerical examples. Assume that the corporate tax rate (τ) is 35 percent, that the payout ratio (f) is 50 percent, and that the economic depreciation rate (δ) and the fiscal depreciation rate (γ) are both 15 percent. Further, let the real interest rate (i) be 5 percent and let the personal tax rate on capital income (τ_{pi}) be 30 percent. The marginal shareholder faces a dividend tax rate (τ_{pd}) of 30 percent and an effective capital gains tax rate (τ_{pc}) of 15 percent.[38] The numerical illustration focuses on the characteristic parameters of each method, summarized in table 2.

[38] The personal tax rate on capital gains is set to half the personal tax rate on dividends.

Table 2. The characteristic parameters.

Method	Characteristic Parameter (CP)	Initial value (percent)
Reduced personal tax rate on dividends	τ_{pd}	30
Reduced personal tax rate on capital gains	τ_{pc}	15
Reduced corporate tax rate	τ	35
Increased allowances	γ	15
The imputation system	ϕ	0
The split rate system	τ_d	35
Dividend deduction	β	0
The Annell deduction	a	0
The SURV	ξ	0
The periodization fund	α	0
The reverse imputation system	ε	0

Note: When the characteristic parameter equals its initial value, we have a pure classical system.

The new share issue regime

Assume first that the cost of capital is reduced by a cut in the statutory corporate tax rate from its initial value of 35 percent to 25 percent. Column II of table 3 then gives the values for each of the characteristic parameters that, ceteris paribus, would be required to accomplish the same reduction in the cost of capital. For instance, an increase in the rate of fiscal depreciation from 15 percent (see column I) to 26 percent (column II) would have the same impact on the cost of capital as a 10-percentage point corporate tax cut.

Table 3. Tax-policy experiments, the new share issue regime (in percent).

CP	Column I (initial value)	Column II $\tau = .25$	Column III $\tau_d = 0$	Column IV $\tau_{pd} = 0$	Column V $\tau_{pc} = 0$	Column VI $\alpha = .25$	Column VII $\tau = 0$
τ_{pd}	30	8	0	-	16	25	.
τ_{pc}	15	.	.	.	-	10	.
τ	35	-	23	23	29	33	-
γ	15	26	32	32	21	17	∞
ϕ	0	24	30	30	18	7	.
τ_d	35	12	-	0	22	31	.
β	0	76	100	100	50	19	.
a	0	26	.	.	4	1	.
ξ	0	36	46	46	25	10	100
α	0	63	72	72	50	-	100
ε	0	54	70	70	37	14	.

The remaining columns of table 3 present the results of several tax-policy experiments, including abolition of the corporate tax on distributed profits (column III) and of the personal tax on dividends (column IV). Although being schemes at different levels - the split rate system at the firm level and abolishment of dividend taxation at the shareholder level - they have the same effect on the cost of capital.

Let us just comment on a couple of further insights from table 3. The cost of capital following on the hypothetical scenario of a zero corporate tax rate (see column VII) can only be reached by methods based on allocations to the SURV or the periodization fund, or an immediate write-off of investment costs. All other methods require higher or lower rates than allowed (indicated by a dot). However, today's rate of allocation to the periodization fund ($\alpha = .25$) in Sweden only requires minor adjustments of the other characteristic parameters (as compared to the initial values) to give the same reduction in the cost of capital (column VI). Further, abolishing the personal tax rate on capital gains (column V), which is a widely used double tax relief, has a low impact on the other characteristic parameters, i.e. has a minor impact on the cost of capital.

The retention regime

Table 4 presents the magnitude for each of the characteristic parameters in the retention regime that, ceteris paribus, would be required to accomplish the same reduction in the cost of capital as when $\tau_{pc} = 0$ and $\tau = 0$.[39]

Table 4. Tax-policy experiments, the retention regime (in percent).

CP	$\tau_{pc} = 0$	$\tau = 0$
τ_{pc}	-	.
τ	24	-
γ	29	∞
ξ	43	100
α	69	100
ε	100	.

[39] The other tax-policy experiments reported in table 3 have no effect on the cost of capital in the retention regime.

4.3 The King-Fullerton effective tax rate

The methodology put forward by King and Fullerton (1984) for calculating effective tax rates has become the internationally most well-known approach for comparing tax regimes between countries and over time, and it has been used in numerous studies. Following King and Fullerton, the pre-tax rate of return on investment is *p*, and *s* is the post-tax rate of return on savings. The tax wedge is defined as $w = p - s$, and the King-Fullerton (K-F) effective tax rate is defined as the ratio between the tax wedge and the rate of return on investment, i.e. $t = \frac{w}{p}$. The *K-F effective tax rate* is therefore[40]

$$t = 1 - \frac{(1-\tau_{pi})i}{F_K^{method,\, regime} - \delta}. \tag{35}$$

This approach offers a simple and highly useful way of comparing the different methods of mitigating double taxation, with the K-F effective tax rate for the pure classical system used as a benchmark (with the parameter values as in table 2). The lower the K-F effective tax rate, the more effective is the method in reducing double taxation.

In table 5, the K-F effective tax rates have been calculated for 3 different values of each characteristic parameter and the results are presented both for the retention and the new share issue regimes. In the new share issue regime, the K-F effective tax rates have also been calculated for different values of the payout ratio.[41] Table 5 contains a great deal of information, but we will just comment on how to read the table and emphasize the main findings.

[40] To illustrate the meaning of the K-F effective tax rate, consider the following simplified example. The corporation shows a profit before corporate tax of 100 units, all of which is distributed as dividends. Assuming a corporate tax rate of 35 percent implies that the post-tax corporate profit is 65 units. Out of the 65 units, shareholders receive 45.5 units and pay 19.5 in dividend tax, if the personal dividend tax rate equals 30 percent. The K-F effective tax rate on corporate income is then 54.5 percent. This is the K-F effective tax rate for a corporation in the pure classical system in the new share issue regime with a payout ratio equal to one.

[41] The payout ratio can be interpreted as the relative importance for the shareholder of receiving dividends. This, in turn, may reflect the shareholder's desire for receiving information (dividends used as a signal) or reducing the so-called free cash flow problem.

Table 5. The King-Fullerton effective tax rates (in percent).

Method	Characteristic Parameter		The Retention Regime	The New Share Issue Regime			
				$f = .25$	$f = .5$	$f = .75$	$f = 1$
The benchmark case, parameter values as of table 2.			44.8	47.2	49.6	52.1	54.5
Reduced personal tax rate	τ_{pd}	.2	44.8	45.6	46.4	47.2	48.0
on dividends		.1	44.8	43.9	43.1	42.3	41.5
		0	44.8	42.3	39.9	37.4	35.0
Reduced personal tax rate	τ_{pc}	.1	41.5	44.8	48.0	51.3	54.5
on capital gains		.05	38.3	42.3	46.4	50.4	54.5
		0	35.0	39.9	44.8	49.6	54.5
Reduced corporate tax rate	τ	.25	36.3	39.1	41.9	44.7	47.5
		.15	27.8	30.9	34.1	37.3	40.5
		0	15.0	18.8	22.5	26.3	30.0
Increased allowances	γ	.3	34.7	37.6	40.5	43.3	46.2
		.6	26.8	30.0	33.2	36.5	39.7
		∞	15.0	18.8	22.5	26.3	30.0
The imputation system	ϕ	.15	44.8	45.2	45.6	46.0	46.5
		.25	44.8	43.4	42.0	40.7	39.3
		.35	44.8	41.1	37.4	33.7	30.0
The split rate system	τ_d	.25	44.8	45.3	45.9	46.5	47.1
		.15	44.8	43.9	43.1	42.3	41.5
		0	44.8	42.4	40.0	37.6	35.2
Dividend deduction	β	.25	44.8	46.0	47.2	48.4	49.7
		.5	44.8	44.8	44.8	44.8	44.8
		1	44.8	42.4	40.0	37.6	35.2
The Annell deduction	a	.1	44.8	43.9	43.1	42.3	41.4
		.2	44.8	43.6	42.4	41.3	40.1
		.3	44.8	43.5	42.2	40.9	39.6
The SURV	ξ	.15	41.7	44.3	46.8	49.4	52.0
		.5	33.0	36.0	38.9	41.9	44.8
		1	15.0	18.8	22.5	26.3	30.0
The periodization fund	α	.25	42.8	45.3	47.8	50.3	52.9
		.5	39.5	42.2	44.8	47.5	50.2
		1	15.0	18.8	22.5	26.3	30.0
The reverse imputation system	ε	.25	42.9	44.5	46.4	48.3	50.2
		.5	40.7	41.6	42.9	44.2	45.5
		1	35.0	35.0	35.0	35.0	35.0

The new share issue regime

Common for all methods, except for the Annell deduction, is that the K-F effective tax rate increases with the payout ratio (for moderate changes in initial values of the characteristic parameters).[42] It follows from a higher payout ratio that a larger fraction of capital is distributed as dividends, which is taxed at the higher personal tax rate on dividends (as compared to capital gains). Methods based on a reduced tax rate on distributed income would be expected to perform relatively better with a higher payout ratio. This is confirmed in the calculations and is best illustrated by comparing the schemes based on reduced τ_{pd} and reduced τ_{pc} for the hypothetical case where $\tau_{pd} = \tau_{pc} = 0$.

The retention regime

There are five methods with the same K-F effective tax rate as in the benchmark case, independent of the value of the characteristic parameter, viz. a reduced τ_{pd}, the imputation system, the split rate system, the dividend deduction and the Annell deduction. Accordingly, these methods do not reduce the K-F effective tax rate under the retention regime and, hence, corporate income is taxed twice.[43]

5 Summary of the results and other perspectives on tax integration

A large number of schemes for reducing double taxation have been modeled in a simple cost of capital framework. Both internationally well-known methods and more specific methods used in Sweden have been compared. Some of the methods are labeled as trivial, implying only reduced tax rates or increased allowances, while the genuine schemes require more extensive changes in the tax structure.

The main conclusion is that all methods manage to mitigate double taxation to some extent when the marginal investment is financed with new equity. However, when the marginal investment is financed with retained earnings, two of the most well-known and most utilized

[42] For the Annell deduction, the K-F effective tax rate falls with a higher payout ratio for all values of the characteristic parameter. When the corporation increases its dividends, the stock of newly issued equity will increase since a larger amount of new equity is required for additional investments. This, in turn, will increase the amount of Annell deduction.

[43] Naturally, this is the same conclusion as in the analytical derivations of the adjusted tax rate in section 3.

methods, the imputation system at the shareholder level and the split rate system at the corporate level, leave the cost of capital unaffected. The same is true both for a dividend deduction at the corporate level and a reduced dividend tax rate at the shareholder level. Abolishment of the personal tax rate on capital gains, which is a widely used method that reduces double taxation in both regimes, still implies a high King-Fullerton effective tax rate on distributed income, i.e. the method has a minor effect on double taxation of corporate income. Besides showing the importance of the source of finance, this paper also illustrates how the dividend payout ratio, which differs considerably among firms, affects the cost of capital. The higher is the payout ratio the higher is the cost of capital.

From the perspective of reducing the cost of capital many of the schemes examined are equivalent. An interesting question is then whether there are other considerations that may cause the governments to choose a particular tax integration scheme. We will tentatively discuss this question below, drawing on the analysis of this paper.

Employing a tax integration scheme creates a cost for the government in terms of forgone tax revenue. The obvious goal for the government would seem to be to reduce the cost of capital as much as possible, given some level of forgone tax revenue. As is clear from the analysis, the source of finance at the margin is a matter of decisive importance for the outcome of a particular method. However, the precise design of the methods matters too. The Annell deduction, the imputation system, the split rate system and dividend deduction all have in common that they reduce the cost of capital in the new share issue regime only. If a reduced cost of new equity is also the policy objective the Annell deduction should be the first choice. The reason for this is that the Annell deduction offers a tax rate reduction to dividends on newly issued shares, not to all dividends. For a given forgone tax revenue, it is, hence, more effective to introduce an Annell deduction than, for instance, an imputation system.

On the other hand, if the aim is to reduce the cost of capital in both regimes, i.e. to both mature (assumed to make use of retained earnings) and newly started (assumed to make use of new equity) corporations, a variety of methods are available, e.g. a reduction in the corporate income tax rate, increased allowances, allocation to periodization funds and allocation to tax equalization reserves.

The varying approaches to corporate tax integration in Sweden during the 1990's may be seen as a result of how political ideologies affect technical solutions in the tax structure.[44] At the beginning of the 1990's Sweden had a Social Democratic government. The methods employed up to that date were all at the corporate level. During the non-socialist government, 1991-94, the personal dividend tax was reduced and eventually eliminated in 1994. The stated motive was to stimulate households to invest in shares and increase the private ownership of corporations, which may be seen as an ideological objective of a non-socialist government.[45] The double tax relief shifted from corporations to shareholders with small or even negative impact, i.e. a higher cost, on the cost of capital according to Bergström and Södersten (1994). After the election in the fall of 1994, the new the Social Democratic government restored its previous policy and reintroduced a tax relief at the corporate level (the periodization fund).

One reason for choosing an imputation system at the shareholder level is the desire to maintain a comprehensive income tax where corporate income will be taxed at the shareholders' marginal tax rate. The marginal tax rate will then depend on the shareholder's identity, reflecting the degree of progressiveness in the income tax system. Two of the Nordic countries, Finland and Norway, switched to an imputation system at the beginning of the 1990's.[46] This was part of the major tax reforms taking place in the Nordic countries when the so-called dual income tax system was introduced. Under the Nordic dual income tax, capital income is taxed at a proportional rate lower than the top marginal tax rate on labor income. Introducing an imputation system into the dual income tax structure seems strange, where the policy objective is no longer to tax corporate income at progressive income tax rates. However, the governments in Finland and Denmark stressed the importance of international harmonization and suggested pedagogical reasons for using the more complicated imputation system instead of the simpler method of reducing the proportional personal tax rate on dividends.

[44] Similar political aspects can most likely also be found in other countries.

[45] The reduced personal tax rate is only one example. Another example that strengthens the assertion of ideological differences would be the advantageous rules for very small corporations that the right-wing government in 1991-94 also introduced, see further in Bergström and Södersten (1994).

[46] Both countries used methods at the corporate level based on deduction related to dividends before the tax reforms at the beginning of the 1990's.

A characteristic feature of the corporate tax system in the Nordic countries before the tax reforms was the combination of high nominal corporate tax rates and extensive opportunities for consolidation in terms of tax-free fund allocations and accelerated depreciation. This system was an effective tool also for carrying losses backward, since the consolidated capital could be offset against current losses. As a result, new consolidation capacity for coming years was created. The new dual income tax and the new corporate tax system do not offer the same opportunities.

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Appendix A: The trivial methods

In this appendix we will discuss how changes in an existing tax rate and accelerated depreciation within the pure classical system, i.e. the trivial methods, affect the cost of capital.

A.1 Reduced personal tax rates on dividends and capital gains

Since corporate income is taxed both at the corporate and the personal level, one obvious possibility of mitigating double taxation is to reduce or eliminate one of the existing tax rates.[47] As is clear from (14), the personal tax rate on dividends, τ_{pd}, does not affect the cost of capital in the retention regime. A change in the personal tax rate on dividends is instead capitalized into the market value of the corporation. The market value, as expressed in (2), can be rewritten as $V = \theta^{gm} \int_{t=t_0}^{\infty} De^{-r(t-t_0)}dt$. The capitalization effect is then obvious, since $\theta^{gm} < 1$, and r is independent of τ_{pd}.[48]

The personal tax rate on both dividends and capital gains affect the cost of capital in the new share issue regime.[49] A reduction in the personal tax rate on dividends and/or capital gains reduces the cost of capital, as is clear from (17). The magnitude of the reduction depends on the corporation's payout ratio *f*. If the payout ratio is small, close to zero, changes in τ_{pc} will have significant effects on the cost of capital. This case is similar to the retention regime, with the important difference in the amount of distributed income. The corporation pays dividends in excess of the payout ratio according to the retention regime. If *f* is close to zero in the new share issue regime, the corporation distributes a small amount of dividends and, therefore, shareholders pay a dividend tax near zero. Hence, the dividend tax rate has a very limited effect on the cost of capital. The other extreme is when the payout ratio is high, i.e. *f* is close

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[47] A reduced tax rate on capital income, τ_{pi}, increases the corporate cost of capital. Remember that τ_{pi} is used only as the tax rate on interest income and, since a separate tax parameter for dividends is introduced, we will not discuss τ_{pi} further.

[48] Note from the general model that $q = \theta^{gm} < 1$ in equilibrium in this regime, as long as the effective tax rate on dividends is higher than that on capital gains.

[49] In this regime, $q = \theta^{gm} = 1$ in steady state, reflecting that new investments must bear the personal dividend tax.

to unity. A reduction in the dividend tax rate is then an appropriate method for reducing the cost of capital, since most of the income is distributed as dividends.

As an extreme case, the personal tax rate on dividends and capital gains may be reduced to zero, i.e. $\tau_{pd} = \tau_{pc} = 0$. In the retention regime, this implies a reduced cost of capital and a considerable windfall gain for the shareholders. The cost of capital is reduced even further in the new share issue regime since both rates affect the cost of capital. In fact, in the pure classical system, i.e. $\delta = \gamma$, the costs of capital coincide

$$F_K^{RR} = F_K^{NSIR} = \delta + \frac{1-\tau_{pi}}{1-\tau} i \,. \tag{A1}$$

A.2 Reduced corporate tax rate

The effect on the cost of capital of a change in the corporate tax rate is the most straightforward method to analyze. Even though the magnitude of the reduction differs between the two regimes, the cost of capital decreases in both. The cost of capital in the retention regime simplifies to

$$F_K^{RR} = \delta + r \quad , \tag{A2}$$

in the extreme case $\tau = 0$. The corresponding expression in the new share issue regime is

$$F_K^{NSIR} = \delta + \frac{r}{1-\left(1-\theta^{gm}\right) f} \,. \tag{A3}$$

Accelerated depreciation, i.e. the difference between δ and γ, does not affect the cost of capital when the corporate tax rate is equal to zero.

A.3 Increased allowances

Accelerated depreciation allows the corporation to defer tax payments, which is tantamount to obtaining an interest-free loan from the government. This interest-free loan reduces the cost of the marginal investment. Hence, one possible method for reducing double taxation is to allow the corporation larger allowances (including e.g. an investment tax credit). Increased allowances will be modeled by letting the maximum fiscal depreciation rate rise in the general model. The impact of allowances on the cost of capital is best illustrated if considering three different cases: the pure classical system where no accelerated depreciation is allowed, accelerated depreciation as in the general model or an immediate write-off of investment costs.

In the pure classical system where the fiscal depreciation rate, γ, equals the true economic depreciation rate, δ, the term $\frac{\gamma-\delta}{\gamma+r}\tau$ in expressions (13) and (15) vanishes. This means that the share of the marginal investment financed by deferred tax payments equals zero and, hence, that the marginal investment is solely financed with corporate equity. The cost of capital becomes

$$F_K^{RR,\gamma=\delta} = \delta + \frac{r}{1-\tau} \tag{A4}$$

and

$$F_K^{NSIR,\gamma=\delta} = \delta + \frac{r}{1-\tau_{gm}^*} = \delta + \frac{r}{1-\tau}\frac{1}{\left(1-\left(1-\theta^{gm}\right)f\right)}. \tag{A5}$$

The cost of capital has increased in both regimes, as compared to the general model, see expressions (13) and (15). Note that the cost is greater under the new share issue regime, as compared to the retention regime, as was also the case under the classical system, but the difference has increased.

The case where the corporation is allowed to directly write off the investment costs is calculated as $\bar{F}_K\left(K\right) = \lim_{\gamma\to\infty} F_K\left(K\right)$, which implies that the cost of capital becomes

$$\bar{F}_K^{RR} = \delta + r \tag{A6}$$

and

$$\bar{F}_K^{NSIR} = \delta + \frac{r}{1-\left(1-\theta^{gm}\right) f} . \tag{A7}$$

The costs have fallen as compared to the pure classical system, since the possibility to defer tax payment reduces the fraction of equity finance at the margin. The cost of capital is unaffected by the corporate tax when investment costs are written off directly. Furthermore, note that the difference in the cost of capital between the two regimes has been reduced. In summary, the cost falls faster in the new share issue regime as γ becomes larger, since a greater share of new investments is financed with the interest-free loan from the government.

Appendix B: Calculations

Some of the calculations and derivations are presented in this appendix, but the focus is on presenting the first order conditions from the optimization procedure. A comprehensive derivation of the general model is given in B.1, from which many of the other methods follow straightforward, simply by redefinitions of relevant parameters.

B.1 The general model

Constraints:

$$D = (1-\tau)F(K) + N - I + \tau\gamma C \quad (3)$$

$$D \geq f(1-\tau)\big(F(K) - \delta K\big) \quad (4)$$

$$N \geq 0 \quad (5)$$

$$\dot{C} = I - \gamma C \quad (6)$$

$$\dot{K} = I - \delta K \quad (7)$$

The problem to maximize:

$$\text{Max } V(K,C) = \int_{t=t_0}^{\infty} \Lambda\big(K,\dot{K},C,\dot{C},I,N,D;t\big)e^{-r(t-t_0)}dt \text{ , where}$$

$$\Lambda(\cdot) = \theta^{gm}D - N + \mu_D\big[(1-\tau)F(K) + \tau\gamma C + N - I - D\big]$$
$$+\eta_D\big[D - f(1-\tau)\big(F(K) - \delta K\big)\big] + \eta_N N + \mu_C\big[I - \gamma C - \dot{C}\big] + \mu_K\big[I - \delta K - \dot{K}\big]$$

The first order conditions:

$$I: \qquad -\mu_D + \mu_K + \mu_C = 0 \quad (8)$$

$$N: \qquad -1 + \mu_D + \eta_N = 0 \quad (9)$$

$$D: \qquad \theta^{gm} - \mu_D + \eta_D = 0 \quad (10)$$

$$K: \qquad (\mu_D - f\eta_D)(1-\tau)F_K - \mu_K(\delta + r) + \eta_D f(1-\tau)\delta + \dot{\mu}_K = 0 \quad (11)$$

$$C: \qquad \mu_D\tau\gamma - \mu_C(\gamma + r) + \dot{\mu}_C = 0 \quad (12)$$

The assumption of a steady state solution implies that $\dot{\mu}_K = \dot{\mu}_C = 0$, which is used in all coming derivations.

The retention regime (RR)

$\eta_N > 0$ and $\eta_D = 0$, which gives following first order conditions:

$$C': \qquad \mu_C = \mu_D \frac{\tau\gamma}{\gamma + r}$$

$$I': \qquad \mu_K = \mu_D - \mu_C = \mu_D \left(\frac{\gamma(1-\tau) + r}{\gamma + r} \right)$$

$$K': \qquad \begin{cases} F_K = \dfrac{\mu_K(\delta + r)}{\mu_D(1-\tau)} \\ \quad = \dfrac{r(\delta + r) + \gamma(1-\tau)(\delta + r)}{(1-\tau)(\gamma + r)} \end{cases}$$

Add δ and subtract $\delta \frac{(1-\tau)(\gamma+r)}{(1-\tau)(\gamma+r)}$ in *K'*, which gives the following:

$$\begin{aligned} F_K &= \delta + \frac{r(\delta + r) + \gamma(1-\tau)(\delta + r) - \delta(1-\tau)(\gamma + r)}{(1-\tau)(\gamma + r)} \\ &= \delta + \frac{r(\gamma + r) - r\tau(\gamma - \delta)}{(1-\tau)(\gamma + r)} \end{aligned}$$

The cost of capital under the retention regime then follows as

$$F_K = \delta + \frac{r}{1-\tau}\left(1 - \frac{\gamma - \delta}{\gamma + r}\tau\right). \qquad (13)$$

The new share issue regime (NSIR)

$\eta_N = 0$ and $\eta_D > 0$, which gives following first order conditions:

$$C': \qquad \mu_C = \mu_D \frac{\tau\gamma}{\gamma + r}$$

$$I': \qquad \mu_K = \mu_D - \mu_C = \mu_D \left(\frac{\gamma + r - \tau\gamma}{\gamma + r} \right)$$

$$K': \quad \begin{cases} F_K = \dfrac{\mu_K(\delta+r)-\eta_D f(1-\tau)\delta}{(\mu_D - f\eta_D)(1-\tau)} \\ \quad = \dfrac{\mu_D\left(\dfrac{\gamma+r-\tau\gamma}{\gamma+r}\right)(\delta+r)-\eta_D f(1-\tau)\delta}{(1-\tau)(\mu_D - f\eta_D)} \\ \quad = \dfrac{\mu_D(\gamma+r-\tau\gamma)(\delta+r)-\eta_D f(1-\tau)(\gamma+r)\delta}{(1-\tau)(\mu_D - f\eta_D)(\gamma+r)} \end{cases}$$

Add δ and subtract $\delta\dfrac{(1-\tau)(\mu_D - f\eta_D)(\gamma+r)}{(1-\tau)(\mu_D - f\eta_D)(\gamma+r)}$ in *K'*, which gives the following:

$$F_K = \delta + \frac{\begin{Bmatrix} \mu_D(\gamma+r-\tau\gamma)(\delta+r)-\eta_D f(1-\tau)(\gamma+r)\delta - \\ (1-\tau)(\mu_D - f\eta_D)(\gamma+r)\delta \end{Bmatrix}}{(1-\tau)(\mu_D - f\eta_D)(\gamma+r)}$$

$$= \delta + \frac{\begin{Bmatrix} \mu_D\left(\gamma\delta + r\delta - \tau\gamma\delta + \gamma r + r^2 - \tau\gamma r\right) - \eta_D f(1-\tau)(\gamma+r)\delta \\ -\mu_D(\gamma\delta - \tau\gamma\delta + r\delta - \tau r\delta) + \eta_D f(1-\tau)(\gamma+r)\delta \end{Bmatrix}}{(1-\tau)(\mu_D - f\eta_D)(\gamma+r)}$$

$$= \delta + \frac{\mu_D\left(\gamma r + r^2 - \tau\gamma r + \tau\delta r\right)}{(1-\tau)(\mu_D - f\eta_D)(\gamma+r)}$$

$$= \delta + \frac{\mu_D\left(r(\gamma+r) - \tau r(\gamma-\delta)\right)}{\mu_D(1-\tau)(\gamma+r)\left(1 - f\dfrac{\eta_D}{\mu_D}\right)}$$

$$= \delta + \frac{r}{(1-\tau)\left(1 - f\dfrac{\eta_D}{\mu_D}\right)}\left(1 - \frac{\gamma-\delta}{\gamma+r}\tau\right)$$

Since $\mu_D = 1$ in the general model under the new share issue regime, see expression (9), η_D is given by $\eta_D = \mu_D - \theta^{gm} = 1 - \theta^{gm}$ from (10), which gives the cost of capital as

$$F_K = \delta + \frac{r}{1-\tau_{gm}^*}\left(1 - \frac{\gamma - \delta}{\gamma + r}\tau\right), \tag{15}$$

where

$$\tau_{gm}^* = \tau + (1-\tau)\left(1-\theta^{gm}\right) f \ . \tag{16}$$

B.2 The split rate system

Given the tax liability in (19), the budget constraint is

$$D = (1-\tau_d) F(K) + \varphi\left(\tau\gamma C + N - I\right), \tag{20}$$

where $\varphi = \frac{1-\tau_d}{1-\tau}$.

The lambda function in the optimization problem becomes:

$$\begin{aligned}&\Lambda(\cdot) = \theta^{gm} D - N + \mu_D\left[(1-\tau_d) F(K) + \varphi\left(\tau\gamma C + N - I\right) - D\right] \\ &+\eta_D\left[D - f(1-\tau_d)\left(F(K) - \delta K\right)\right] + \eta_N N + \mu_C\left[I - \gamma C - \dot{C}\right] + \mu_K\left[I - \delta K - \dot{K}\right]\end{aligned}$$

The first order conditions in steady state, i.e. $\dot{\mu}_K = \dot{\mu}_C = 0$, become:

$I:$ $\quad -\mu_D\varphi + \mu_K + \mu_C = 0$

$N:$ $\quad -1 + \mu_D\varphi + \eta_N = 0$

$D:$ $\quad \theta^{gm} - \mu_D + \eta_D = 0$

$K:$ $\quad (\mu_D - f\eta_D)(1-\tau_d) F_K - \mu_K(\delta + r) + \eta_D f(1-\tau_d)\delta = 0$

$C:$ $\quad \mu_D\varphi\tau\gamma - \mu_C(\gamma + r) = 0$

Using the same line of actions as in B.1 gives the cost of capital as reported in table C.1 in appendix C.

B3 Dividend deduction

Plugging the tax function $T = \tau\left(F(K) - \gamma C - \beta D\right)$ into the corporation's cash flow, i.e. $D = F(K) + N - I - \tau\left(F(K) - \gamma C - \beta D\right)$, gives the budget constraint as in the main text

$$(1-\tau\beta)D=(1-\tau)F(K)+N-I+\tau\gamma C\,. \tag{22}$$

The lambda function in the optimization problem becomes:

$$\begin{aligned}&\Lambda(\cdot)=\theta^{gm}D-N+\mu_D\left[(1-\tau)F(K)+\tau\gamma C+N-I-(1-\tau\beta)D\right]\\&+\eta_D\left[D-f(1-\tau)\big(F(K)-\delta K\big)\right]+\eta_N N+\mu_C\left[I-\gamma C-\dot{C}\right]+\mu_K\left[I-\delta K-\dot{K}\right]\end{aligned}$$

The first order conditions in steady state, i.e. $\dot{\mu}_K=\dot{\mu}_C=0$, become:

$$\begin{aligned}&I: && -\mu_D+\mu_K+\mu_C=0\\&N: && -1+\mu_D+\eta_N=0\\&D: && \theta^{gm}-\mu_D(1-\tau\beta)+\eta_D=0\\&K: && (\mu_D-f\eta_D)(1-\tau)F_K-\mu_K(\delta+r)+\eta_D f(1-\tau)\delta=0\\&C: && \mu_D\tau\gamma-\mu_C(\gamma+r)=0\end{aligned}$$

Using the same line of actions as in B.1 gives the cost of capital as reported in table C.1 in appendix C.

B.4 The Annell deduction

The Annell deduction gives rise to a tax deduction of the amount

$$\Omega=\frac{\tau a}{r}\left[1-e^{-r\omega}\right], \tag{24}$$

as in the main text, which implies the following budget constraint

$$D=(1-\tau)F(K)+(1+\Omega)N-I+\tau\gamma C\,. \tag{25}$$

The lambda function in the optimization problem becomes:

$$\begin{aligned}&\Lambda(\cdot)=\theta^{gm}D-N+\mu_D\left[(1-\tau)F(K)+(1+\Omega)N-I+\tau\gamma C-D\right]\\&+\eta_D\left[D-f(1-\tau)\big(F(K)-\delta K\big)\right]+\eta_N N+\mu_C\left[I-\gamma C-\dot{C}\right]+\mu_K\left[I-\delta K-\dot{K}\right]\end{aligned}$$

The first order conditions in steady state, i.e. $\dot{\mu}_K=\dot{\mu}_C=0$, become:

$$I: \qquad -\mu_D + \mu_K + \mu_C = 0$$

$$N: \qquad -1 + \mu_D \left(1 + \Omega\right) + \eta_N = 0$$

$$D: \qquad \theta^{gm} - \mu_D + \eta_D = 0$$

$$K: \qquad \left(\mu_D - f\eta_D\right)\left(1-\tau\right)F_K - \mu_K\left(\delta + r\right) + \eta_D f\left(1-\tau\right)\delta = 0$$

$$C: \qquad \mu_D \tau\gamma - \mu_C\left(\gamma + r\right) = 0$$

Using the same line of actions as in B.1 gives the cost of capital as reported in table C.1 in appendix C.

B.5 Allocation to the tax equalization reserve (SURV)

Plugging the tax function $T = \tau\left(F\left(K\right) - \gamma C - \xi\dot{C}\right)$ into the corporation's cash flow constraint $D = F\left(K\right) + N - I - \tau T$ gives the following budget constraint (not reported in the main text)

$$D = \left(1-\tau\right)F\left(K\right) + \tau\gamma C + N - I + \tau\xi\dot{C}\,. \tag{B1}$$

The lambda function in the optimization problem becomes:

$$\Lambda\left(\cdot\right) = \theta^{gm}D - N + \mu_D\left[\left(1-\tau\right)F\left(K\right) + \tau\gamma C + N - I + \tau\xi\dot{C} - D\right]$$
$$+\eta_D\left[D - f\left(1-\tau\right)\left(F\left(K\right) - \delta K\right)\right] + \eta_N N + \mu_C\left[I - \gamma C - \dot{C}\right] + \mu_K\left[I - \delta K - \dot{K}\right].$$

The first order conditions in steady state, i.e. $\dot{\mu}_K = \dot{\mu}_C = 0$, become:

$$I: \qquad -\mu_D + \mu_K + \mu_C = 0$$

$$N: \qquad -1 + \mu_D + \eta_N = 0$$

$$D: \qquad \theta^{gm} - \mu_D + \eta_D = 0$$

$$K: \qquad \left(\mu_D - f\eta_D\right)\left(1-\tau\right)F_K - \mu_K\left(\delta + r\right) + \eta_D f\left(1-\tau\right)\delta = 0$$

$$C: \qquad \mu_D \tau\left(\gamma + r\xi\right) - \mu_C\left(\gamma + r\right) = 0$$

Using the same line of actions as in B.1 gives the cost of capital as in table C.1 in appendix C.

B.6 The reverse imputation system

In the main text, we derived the tax liability as

$$T = \tau\left(F(K) - \gamma C\right) - \varepsilon\left(\tau_{pd} D - \tau_{pc}\left(\dot{V} - N\right)\right), \tag{29}$$

which implies that the corporation's budget constraint becomes (not reported in the main text)

$$D = \frac{(1-\tau)F(K) + N - I + \tau\gamma C}{1-\varepsilon\tau_{pd}} + \frac{\varepsilon\tau_{pc}}{1-\varepsilon\tau_{pd}}\left(\dot{V} - N\right). \tag{B2}$$

Since dividends in (B2) depend on the change in the firm's market value, we have to substitute for D in the non-arbitrage condition (1), i.e.

$$i\left(1-\tau_{pi}\right)V = \left(1-\tau_{pd}\right)\left[\frac{(1-\tau)F(K) + N - I + \tau\gamma C}{1-\varepsilon\tau_{pd}} + \frac{\varepsilon\tau_{pc}}{1-\varepsilon\tau_{pd}}\left(\dot{V} - N\right)\right] + \left(1-\tau_{pc}\right)\left(\dot{V} - N\right). \tag{B3}$$

Rewriting and collecting terms, we obtain:

$$\dot{V} - \frac{i\left(1-\tau_{pi}\right)}{\left(1 - \frac{\tau_{pc}(1-\varepsilon)}{1-\varepsilon\tau_{pd}}\right)}V = -\frac{\left(1-\tau_{pd}\right)}{\left(1-\varepsilon\tau_{pd}\right)\left(1 - \frac{\tau_{pc}(1-\varepsilon)}{1-\varepsilon\tau_{pd}}\right)}\left[(1-\tau)F(K) + N - I + \tau\gamma C\right] + N$$

or

$$\dot{V} - \frac{i\left(1-\tau_{pi}\right)\left(1-\varepsilon\tau_{pd}\right)}{\left(1-\tau_{pc}\right)\left(1-\varepsilon\left(\frac{\tau_{pd}-\tau_{pc}}{1-\tau_{pc}}\right)\right)}V = -\frac{\left(1-\tau_{pd}\right)}{\left(1-\tau_{pc}\right)\left(1-\varepsilon\left(\frac{\tau_{pd}-\tau_{pc}}{1-\tau_{pc}}\right)\right)}\left[(1-\tau)F(K) + N - I + \tau\gamma C\right] + N.$$

Define

$$r^{ris} = \frac{i\left(1-\tau_{pi}\right)\left(1-\varepsilon\tau_{pd}\right)}{\left(1-\tau_{pc}\right)\left(1-\varepsilon\left(\frac{\tau_{pd}-\tau_{pc}}{1-\tau_{pc}}\right)\right)} = r\frac{1-\varepsilon\tau_{pd}}{1-\varepsilon\left(1-\theta^{gm}\right)} \tag{B4}$$

and

$$\theta^{ris} = \frac{\left(1-\tau_{pd}\right)}{\left(1-\tau_{pc}\right)\left(1-\varepsilon\left(\frac{\tau_{pd}-\tau_{pc}}{1-\tau_{pc}}\right)\right)} = \theta^{gm}\frac{1}{1-\varepsilon\left(1-\theta^{gm}\right)}, \tag{B5}$$

which means that the non-arbitrage condition in the reverse imputation system equals

$$\dot{V} - r^{ris}V = -\theta^{ris}\left[\left(1-\tau\right)F\left(K\right)+N-I+\tau\gamma C\right]+N\,. \tag{B6}$$

Solving the difference equation in (B6), we obtain the corporate market value as

$$V\left(K,C\right) = \int_{t=t_0}^{\infty}\left[\theta^{ris}\left(\left(1-\tau\right)F\left(K\right)+N-I+\tau\gamma C\right)-N\right]e^{-r^{ris}\left(t-t_0\right)}dt\,. \tag{B7}$$

The optimization problem becomes:

$$\max\ V\left(K,C\right) = \int_{t=t_0}^{\infty}\Psi\left(K,\dot{K},C,\dot{C},I,N;t\right)e^{-r^{ris}\left(t-t_0\right)}dt\text{, where}$$

$$\Psi\left(\cdot\right) = \theta^{ris}\left[\left(1-\tau\right)F\left(K\right)+\tau\gamma C+N-I\right]-N+\eta_N N+\mu_C\left[I-\gamma C-\dot{C}\right]+$$
$$\mu_K\left[I-\delta K-\dot{K}\right]+\eta_D\left[\left(1-\tau\right)F\left(K\right)+\tau\gamma C+N-I-f\left(1-\tau\right)\left(F\left(K\right)-\delta K\right)\right]$$

The first order conditions are:

$$I: \qquad -\theta^{ris}-\eta_D+\mu_K+\mu_C=0$$

$$N: \qquad \theta^{ris}-1+\eta_D+\eta_N=0$$

$$K: \qquad \left(\theta^{ris}+\eta_D-f\eta_D\right)\left(1-\tau\right)F_K-\mu_K\left(\delta+r^{ris}\right)+\eta_D f\left(1-\tau\right)\delta=0$$

$$C: \qquad \theta^{ris}\tau\gamma+\eta_D\tau\gamma-\mu_C\left(\gamma+r^{ris}\right)=0$$

The solution for the two regimes follows the solution in the general model in B.1, with the difference in the new definitions of $r = r^{ris}$ and $\theta = \theta^{ris}$ according to (B4) and (B5).

Appendix C: Tables

Table C.1. The corporate cost of capital expressed in terms of r and θ.

Method (characteristic parameter)	**The retention regime**	**The new share issue regime**	**Remark**
The general model	$\frac{r}{1-\tau}\left(1-\frac{\gamma-\delta}{\gamma+r}\tau\right)$	$\frac{r}{1-\tau_{gm}^{*}}\left(1-\frac{\gamma-\delta}{\gamma+r}\tau\right)$	$\tau_{gm}^{*}=\tau+(1-\tau)(1-\theta^{gm})f$, $r=\frac{1-\tau_{pi}}{1-\tau_{pc}}i$ and $\theta^{gm}=\frac{1-\tau_{pd}}{1-\tau_{pc}}$
Reduced corporate tax rate (τ) or Increased allowances (γ)	r	$\frac{r}{1-(1-\theta^{gm})f}$	$\tau=0$ or $\gamma\to\infty$ (immediate write-off)
The imputation system (ϕ)	$\frac{r}{1-\tau}\left(1-\frac{\gamma-\delta}{\gamma+r}\tau\right)$	$\frac{r}{1-\tau_{is}^{*}}\left(1-\frac{\gamma-\delta}{\gamma+r}\tau\right)$	$\tau_{is}^{*}=\tau+(1-\tau)(1-\theta^{is})f$ and $\theta^{is}=\frac{1-\tau_{pi}}{(1-\tau_{pc})(1-\phi)}$
The split rate system (τ_d)	$\frac{r}{1-\tau}\left(1-\frac{\gamma-\delta}{\gamma+r}\tau\right)$	$\frac{r}{1-\tau_{sr}^{*}}\left(1-\frac{\gamma-\delta}{\gamma+r}\tau\right)$	$\tau_{sr}^{*}=\tau+(1-\tau)(1-\varphi\theta^{gm})f$ and $\varphi=\frac{1-\tau_{d}}{1-\tau}$
Dividend deduction (β)	$\frac{r}{1-\tau}\left(1-\frac{\gamma-\delta}{\gamma+r}\tau\right)$	$\frac{r}{1-\tau_{drd}^{*}}\left(1-\frac{\gamma-\delta}{\gamma+r}\tau\right)$	$\tau_{drd}^{*}=\tau+(1-\tau)(1-\theta^{gm}-\tau\beta)f$
The Annell deduction (a)	$\frac{r}{1-\tau}\left(1-\frac{\gamma-\delta}{\gamma+r}\tau\right)$	$\frac{r}{1-\tau_{annell}^{*}}\left(1-\frac{\gamma-\delta}{\gamma+r}\tau\right)$	$\tau_{annell}^{*}=\tau+(1-\tau)(1-\theta^{gm}(1+\Omega))f$ and $\Omega=\tau a\int_{u=t}^{t+\omega}e^{-r(u-t)}du=\frac{\tau a}{r}\left[1-e^{-r\omega}\right]$
Allocation to the SURV (ξ)	$\frac{r}{1-\tau}\left(1-\frac{\gamma-\delta}{\gamma+r}\tau-\frac{\xi(r+\delta)}{\gamma+r}\tau\right)$	$\frac{r}{1-\tau_{gm}^{*}}\left(1-\frac{\gamma-\delta}{\gamma+r}\tau-\frac{\xi(r+\delta)}{\gamma+r}\tau\right)$	
The periodization fund (α)	$\frac{r}{1-\tau'}\left(1-\frac{\gamma-\delta}{\gamma+r}\tau'\right)$	$\frac{r}{1-\tau_{pf}^{*}}\left(1-\frac{\gamma-\delta}{\gamma+r}\tau\right)$	$\tau_{pf}^{*}=\tau'+(1-\tau')(1-\theta^{gm})f$ and $\tau'=\tau\left(1-\alpha\left(\frac{(1+r)^{m}-1}{(1+r)^{m}-\alpha}\right)\right)$
The reverse imputation system (ε)	$\frac{r^{ris}}{1-\tau}\left(1-\frac{\gamma-\delta}{\gamma+r^{ris}}\tau\right)$	$\frac{r^{ris}}{1-\tau_{ris}^{*}}\left(1-\frac{\gamma-\delta}{\gamma+r^{ris}}\tau\right)$	$\tau_{ris}^{*}=\tau+(1-\tau)(1-\theta^{ris})f$, $r^{ris}=r\frac{1-\varepsilon\tau_{pd}}{1-\varepsilon(1-\theta^{gm})}$ and $\theta^{ris}=\theta^{gm}\frac{1}{1-\varepsilon(1-\theta^{gm})}$

Table C.2. The corporate cost of capital expressed in terms of the tax rates, $\delta = \gamma$ for simplicity.

Method (characteristic parameter)	**The retention regime**	**The new share issue regime**	**Remark**
The general model	$\frac{(1-\tau_{pi})i}{(1-\tau)(1-\tau_{pc})}$	$\frac{(1-\tau_{pi})i}{(1-\tau)\left[(1-f)(1-\tau_{pc})+f(1-\tau_{pd})\right]}$	
Reduced corporate tax rate (τ) or Increased allowances (γ)	$\frac{(1-\tau_{pi})i}{1-\tau_{pc}}$	$\frac{(1-\tau_{pi})i}{(1-f)(1-\tau_{pc})+f(1-\tau_{pd})}$	$\tau = 0$ or $\gamma \to \infty$
The imputation system (ϕ)	$\frac{(1-\tau_{pi})i}{(1-\tau)(1-\tau_{pc})}$	$\frac{(1-\tau_{pi})i}{(1-\tau)\left((1-f)(1-\tau_{pc})+f\frac{1-\tau_{pi}}{1-\phi}\right)}$	
The split rate system (τ_d)	$\frac{(1-\tau_{pi})i}{(1-\tau)(1-\tau_{pc})}$	$\frac{(1-\tau_{pi})i}{(1-\tau_r)(1-f)(1-\tau_{pc})+(1-\tau_d)f(1-\tau_{pd})}$	
Dividend deduction (β)	$\frac{(1-\tau_{pi})i}{(1-\tau)(1-\tau_{pc})}$	$\frac{(1-\tau_{pi})i}{(1-\tau)\left[(1-f)(1-\tau_{pc})+f(1-\tau_{pd})+f\tau\beta\right]}$	
The Annell deduction (a)	$\frac{(1-\tau_{pi})i}{(1-\tau)(1-\tau_{pc})}$	$\frac{(1-\tau_{pi})i}{(1-\tau)\left[(1-f)(1-\tau_{pc})+f(1-\tau_{pd})(1+\Omega)\right]}$	$\Omega = \frac{a\tau}{r}\left(1-e^{-r\omega}\right)$
Allocation to the SURV (ξ)	$\frac{(1-\tau_{pi})^2 i(1-\xi\tau)+(1-\tau_{pi})(1-\tau_{pc})(\gamma-\xi\tau\delta)}{(1-\tau)\left((1-\tau_{pi})(1-\tau_{pc})i-(1-\tau_{pc})^2\gamma\right)}$	$\frac{(1-\tau_{pi})^2 i(1-\xi\tau)+(1-\tau_{pi})(1-\tau_{pc})(\gamma-\xi\tau\delta)}{(1-\tau)\left[(1-f)(1-\tau_{pc})+f(1-\tau_{pd})\right]\left[(1-\tau_{pi})i-(1-\tau_{pc})\gamma\right]}$	
The periodization fund (α)	$\frac{(1-\tau_{pi})i}{(1-\tau')(1-\tau_{pc})}$	$\frac{(1-\tau_{pi})i}{(1-\tau')\left[(1-f)(1-\tau_{pc})+f(1-\tau_{pd})\right]}$	$\tau' = \tau\left(1-\alpha\left(\frac{(1+r)^m-1}{(1+r)^m-\alpha}\right)\right)$
The reverse imputation system (ε)	$\frac{(1-\tau_{pi})(1-\varepsilon\tau_{pd})i}{(1-\tau)\left(1-\tau_{pc}-\varepsilon(\tau_{pd}-\tau_{pc})\right)}$	$\frac{(1-\tau_{pi})i}{(1-\tau)\left((1-\tau_{pc})(1-f)+(1-\tau_{pd})\frac{f-\varepsilon\tau_{pc}(1+f)}{1-\varepsilon\tau_{pd}}\right)}$	